Panasonic®

Servo System

# MINAS A7B Series

# Operating Instructions (Overall)

## EtherCAT Rotary Motor

- Thank you for purchasing a Panasonic product.
- Please use it correctly and safely after reading these Operating Instructions (Overall) carefully.
- Read *"1.1.1 Safety Precautions"* before use.
- Keep these Operating Instructions safe.
- This product is for industrial use. It cannot be used for any other (e.g. household) purpose.

Rev.1.1

IMG07
Z0125-3055

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# Introduction

Thank you for purchasing the MINAS A7B Servo System. This manual describes the installation and wiring, trial runs, tuning and operations, and maintenance and inspections of the MINAS A7B Series.

**— Precautions —**

- Unauthorized reproduction or duplication of the contents of the present text, either in whole or in part, is strictly prohibited.
- The contents of the present text (specifications, software versions, etc.) are subject to change without notice.
- This product may be upgraded, including revisions to specifications from the ETG (EtherCAT Technology Group). Please note that we are not responsible for labor and costs associated with the version upgrade.
- Read *"1.1 Precautions"* before using this product.

# On Opening the Product Package

On opening the product package, check the following.

Contact the dealer if there is a problem.

- Make sure that the model matches your order.
- Check whether the product has been damaged during transportation.
- Check whether the safety guide is included.
- At the time of shipment, the power input connector and a motor output connector are attached to the driver body. Check whether they are installed correctly.

# 1 Before Use

## 1.1 Precautions

### 1.1.1 Safety Precautions

- **Must be adhered to**

This section explains precautions that must be taken to prevent harm to people and damage to property.

- **The following symbols represent the extent of the harm or damage that may occur through improper use.**

| | |
|---|---|
| ⚠ **Danger** | This indicates “a significant risk of death or serious injury”. |
| ⚠ **Caution** | This indicates “a risk of injury or property damage”. |

- **The matters to be observed are explained using the following symbols.**

| | |
|---|---|
| 🚫 | Must not be done. |
| ❗ | Must be done. |

| ⚠ **DANGER** | | |
|---|---|---|
| 🚫 | Do not use in wet places, corrosive atmospheres, inflammable gas atmospheres, atmospheres in which gases of low molecular weight such as helium gas are generated, or near combustible materials. | May cause fire. |
| | Do not place combustible materials near the motor, driver, regenerative resistor, or dynamic brake resistor. | |
| | Do not use in places subject to strong vibration or impact. | May cause electric shock, injury, and fire. |
| | Do not use with the cable immersed in oil or water. | May cause electric shock, malfunction, and damage. |
| | Do not install next to a heating element, such as a heater or large coil resistor. | May cause fire and malfunction. |
| | Never connect a commercial power supply directly to the motor. | |
| | Do not perform wiring or operate with wet hands. | May cause electric shock, injury, and fire. |
| | Never put your hand inside the driver. | May cause burns and electric shock. |
| | In the case of a motor with axis end keyway, do not touch the keyway with bare hands. | May cause injury. |
| | Never touch the rotating portion of the motor while it is running. | |
| | Do not touch the motor, driver heat sink, regenerative resistor, or dynamic brake resistor, since they become very hot. | May cause burns and parts damage. |
| | Do not drive the motor with external power. | May cause fire. |
| | Do not damage the cables, subject them to excessive force, place heavy objects on them, or pinch them. | May cause electric shock, malfunction, and damage. |
| ❗ | Install in an area free from excessive dust, water, oil, etc. | Improper installation site conditions may cause electric shock, fire, malfunction or damage. |
| | Install the motor, driver, and peripheral devices to nonflammable materials such as metal. | Mounting on a flammable material may cause fire. |
| | Wiring must be carried out by an expert in electrical work. | Wiring by a person with no expertise may cause electrical shock. |
| | Carry out wiring in accordance with the Operating Instructions. | Incorrect wiring may cause electrical shock, injury, malfunction, or damage. |
| | After correctly connecting cables, insulate the live parts with insulating material. | Incorrect wiring and short circuits may cause electrical shock, fire, or malfunction. |
| | Connect to the earth terminals of the motor and driver without fail. | Not grounding may cause electrical shock. |
| | Install and mount securely to prevent any possible fire or personal injury during an earthquake. | Failure to install properly may cause electric shock, fire, malfunction, or damage. |
| | Install an emergency stop circuit externally so that operation can be stopped and power turned off immediately in the event of an emergency. | |
| | Install an overcurrent protection device, residual current device, overheating prevention device, and emergency stop device without fail. | Failure to install and check these may cause electric shock, injury, or fire. |
| | After an earthquake, always confirm safety. | |
| | Before moving, wiring, or inspecting the driver, turn off power, wait at least as long as specified on the main unit side panel nameplate, and ensure that there is no risk of electrical shock. | Not turning off the power before these operations may cause electric shock. |

## ⚠ CAUTION

| | | |
|---|---|---|
| 🚫 | When transporting the product, do not hold it by the cable or motor axis. | May cause injury. |
| | Do not drop or tip over the product during transportation or installation. | May cause injury or malfunction. |
| | Do not stand on or place heavy objects on the product. | May cause electric shock, injury, malfunction, or damage. |
| | Do not place any objects that would block air passage around the motor, driver, and peripheral devices. | May cause burns or fires. |
| | Do not use in direct sunlight. | May cause injury or fire. |
| | Do not block or insert foreign matter into the heat dissipation holes. | May cause electric shock or fire. |
| | There should be no strong impact on the product. | May cause malfunction. |
| | There should be no strong impact on the motor axis. | May cause detectors, etc., to malfunction. |
| | Do not turn the driver main power on and off frequently. | May cause malfunction. |
| | Never run or stop the motor with the electromagnetic contactor installed on the main power supply side. | |
| | Do not make extreme gain adjustments or changes in the driver, or destabilize the driving or operation of the machine. | May cause injury. |
| | Do not use the motor’s built-in brakes to stop a moving load. | May cause injury or malfunction. |
| | Never modify, dismantle, or repair. | May cause fire, electric shock, injury, or malfunction. |
| ❗ | Mount in a manner appropriately matched to the base machine mass and product rated output. | Improper attachment or installation may cause injury or malfunction. |
| | Observe the specified mounting method and orientation. | |
| | Only use the eye bolt of the motor for transportation of the motor. | Use for transportation of the machine may cause injury or malfunction. |
| | Set the motor and driver ambient temperature within the temperature and humidity ranges for use. | Improper attachment or installation may cause injury or malfunction. |
| | Create the specified clearance in separating the driver from the control panel inner surface and from other devices when installing. | |
| | Maintain the specified voltage. | Operation at a voltage outside the rated voltage range may cause electric shock, injury, or fire. |
| | Connect a relay that disconnects in the event of an emergency stop in series with the brake control relay. | Not connecting it may cause injury or malfunction. |
| | Install safety devices for built-in brake or gear head idling or locking, or grease leakage from gear head. | Non-installation may cause injury, damage, or pollution. |
| | The servo drive may start up with no warning when power is restored after a blackout, so the machine must be set to ensure the safety of the operator at all times. | May cause injury. |
| | Use the specified combination of motor and driver. | May cause malfunction or fire if not used in the correct combination. |
| | To perform a trial run, secure the motor, and install it in the mechanical system after checking its operation while disconnected from the mechanical system. | Use of the wrong model or incorrect wiring may cause injury. |
| | When an error occurs, clear the error and only restart after eliminating the cause and ensuring safety. | Not eliminating the cause of the error might cause injury. |
| | If the driver malfunctions, shut off the power on the power supply side of the driver. | Continued passage of a large current may lead to fire. |
| | Always disconnect the power when not in use for a long time. | Improper operation may cause injury. |
| | Use a stabilized power supply with double insulation or reinforced insulation for the DC power supply. | May cause electric shock , fire or malfunction. |

### ■ Other precautions

- When disposing of batteries, insulate them with tape and dispose of them in accordance with local regulations.
- When disposing of the Servo driver and motor, they are treated as industrial waste.
- Wrinkling of the label affixed to the motor will not present a problem in use of the motor.

## 1.1.2 Precautions for Proper Use

- Observe the following precautions when exporting the product or equipment incorporating the product.

  If the end user or end use of this product is related to the military or weaponry, etc., it may be subject to export restrictions as set forth in the Foreign Exchange and Foreign Trade Act or by the regional authority. When exporting, please review and follow the necessary export procedures.
- This product is intended for use with general industrial products. It is not designed or manufactured for use in machines or systems that may cause death on failure. This product is not for use in devices critical to human wellbeing or in specialized environments, such as nuclear power control, aerospace equipment, transportation systems, medical equipment or various safety devices.
- Installation, wiring, operation and maintenance of the equipment should be carried out by qualified and experienced personnel.
- Apply adequate tightening torque to the product mounting screws by taking into consideration the strength of the screws and the characteristics of the material to which the product is installed.
- Install safety equipment when applying this product to systems that could cause serious accidents or damage in the event of product failure.
- Because noise resistance may be affected by wiring conditions (e.g., earthing methods, cable length, signal wire shielding), please confirm the noise resistance of your equipment.
- Ensure that the motor axis is not operated without being electrically grounded, as this may lead to electrolytic corrosion of the motor bearing and increased bearing noise, depending on the machine and the installation environment.
- Some faults may cause the emission of roughly one cigarette's worth of smoke. Please consider these possibilities when using the device in cleanrooms and similar facilities.
- Make sure to follow indications as overloading products can cause loads to collapse.
- Do not use detergents containing benzine, thinner, alcohol, acid, or alkaline, since this may cause discoloration or damage the exterior of the product. When using a neutral detergent, please use a solution diluted to the concentration specified for the neutral detergent you are using.
- Treat as industrial waste on disposal.
- Please ensure that finished equipment complies with standards, laws and regulations, and confirm that the structure, dimensions, lifetime and characteristics of the product are suitable for your installed equipment and components.
- Note that use of this product outside the scope of specifications is not covered under warranty.
- Reverse engineering, decompiling and disassembling of this product is strictly prohibited.

### 1.1.3 Network Security

As you will use this product connected to a network, your attention is called to the following security risks.

1. Leakage or theft of information through this product
2. Use of this product for fraudulent operation by persons with malicious intent
3. Interference with or stoppage of this product by persons with malicious intent

It is the customer's responsibility to ensure that sufficient network security measures are taken, including the following.

We will not be liable for any damage caused by insufficient network security.

**— Precautions —**

- This product is to be used in an environment where only a limited number of parties are permitted access to the product.
- This product is not to be installed in locations where the product and its accessories, such as cables, can be easily destroyed.
- This product is to be used on a network that is not connected to the Internet.
- If an external device, such as a computer or tablet, is connected to this product, there are concerns about the effects of computer viruses and unauthorized programs.

  Take appropriate security measures with external devices, such as ensuring that they are checked for computer viruses and that regular cleaning of such viruses is performed before connecting them.
- If this product is turned over to a third party for transfer, disposal, repair, etc., important information may be left recorded in the device.

  Make deletions, etc.. at your own risk, and handle such matters with sufficient care.

## 1.2 Related Documents

The following are documents related to this product (including this manual). See each document as necessary for safe use of this product.

The documents can be downloaded from the following site.

*https://industry.panasonic.com/global/en/*

| Document name | Abbreviations in this manual | Document No. | Description |
|---|---|---|---|
| Servo System Operating Instructions | | | |
| MINAS A7B Series Operating Instructions (Overall)<br>EtherCAT Rotary Motor | OI_O | IMG07 | This manual describes the selection, connection, usage, and error handling of servo drivers and servo motors to ensure correct and safe use of this product. |
| MINAS A7B Series Operating Instructions (Tuning)<br>EtherCAT Rotary Motor | OI_A | IMG20 | This document describes the adjustment function of the servo driver. |
| For MINAS Set-up Support Software (PANATERM ver.7) Operating Manual | PT_OM | IMG15 | This document describes how to use PANATERM ver. 7, the setup support software for this product. |
| Servo Driver Standard Specification | | | |
| MINAS A7BSeries Standard Specifications<br>Rotary Motor (Standard / Multi-function / Application specialized) | SS | SX-DSV03714 | This document describes the hardware specifications of the servo driver. |
| Servo Driver Technical Reference | | | |
| MINAS A7B Series Technical Reference Functional Specification<br>Rotary Motor (Standard / Multi-function / Application specialized) | TR_FS | SX-DSV03752 | This document describes how to use the various functions of the servo driver. |
| MINAS A7B Series Technical Reference Communication Specification<br>Rotary Motor (Standard / Multi-function / Application specialized) | TR_CS | SX-DSV03755 | This document describes the interface that connects the servo driver to the host device. |
| Motion Controller User's Manual | | | |
| GM1 Controller User’s Manual (Operation) | GM1_UM | WUME-GM1OP | This document describes how to use the motion controller GM1. |

## 1.3 Product Overview

The Servo System MINAS A7B Series is a network servo system for Ethernet for Control Automation Technology (EtherCAT), a fieldbus system developed by Beckhoff Automation GmbH.

The MINAS A7B Series is connected in a line with an EtherCAT compatible host device using a commercially available LAN cable (CAT5e or higher STP), and combining it with EtherCAT compatible remote units in equipment setups with a high degree of freedom can help to reduce wiring and system costs.

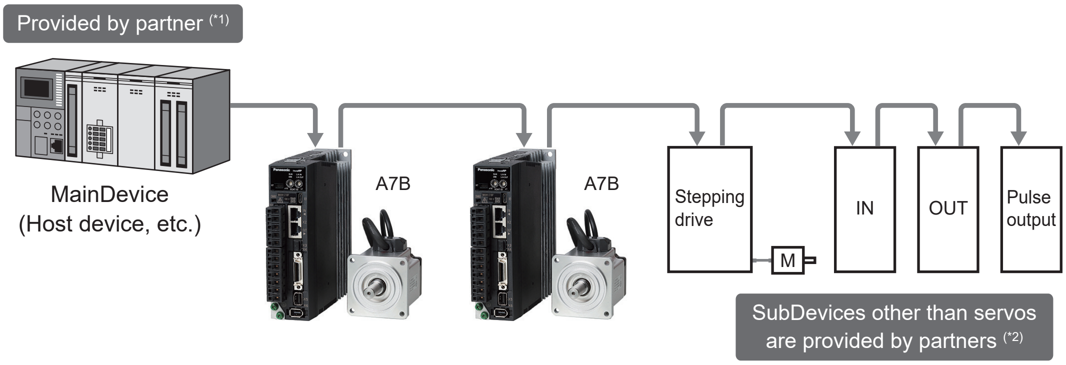
The MINAS A7B Series has a 27-bit encoder resolution (16 times greater than the previous series) to meet needs for faster and more precise positioning as well as greater machine drive than the MINAS A6B Series. It moves smoothly to the targeted position and stops precisely. In addition, the EtherCAT minimum communication cycle is 62.5 µs, a 50% reduction, and the response frequency is 4 kHz, 25% higher than that of the MINAS A6B series, for more detailed control. Furthermore, by improving heat resistance, the maximum operating ambient temperature has been increased to 60°C, allowing the product to be used in a wider range of applications. This is a significant performance improvement over the MINAS A6B Series.

The TUNE COMPASS automatic tuning function adjusts the servo motor to the desired level through selection of the most suitable method from three options with different degrees of tuning time and precision. In particular, precAIse TUNING, an AI tuning method, can easily perform advanced tuning at the micrometer level, by having AI automatically optimize complex tuning that would require several days even for a skilled engineer, simply by setting conditions. Intelligent servos simplify positioning and greatly reduce the amount of engineering labor.

In addition, the MINAS A7B Series includes application specialized models that enable ultra-high-precision control by directly inputting the displacement sensor output to the servo driver. By selecting a model that matches the customer's equipment, labor can be reduced and high performance can be achieved at the same time.

This manual has been prepared as a guide to help you correctly understand and fully use the functions of the MINAS A7B Series, endowed with all of these superior features.

### ■ System configuration example



*1 Please contact the respective partner company for the specifications of products other than servos, such as the host device.

*2 The control mode, communication cycle, and connection of sub devices other than the servo depend on the host device specifications.

## 1.4 EtherCAT Communication

### 1.4.1 EtherCAT Communication Overview

EtherCAT is short for “Ethernet for Control Automation Technology”, and is an open network communication between main devices and sub devices using real-time Ethernet developed by Beckhoff Automation GmbH.

EtherCAT is managed by ETG (EtherCAT Technology Group).

EtherCAT® is registered trademark and patented technology,
licensed by Beckhoff Automation GmbH, Germany.

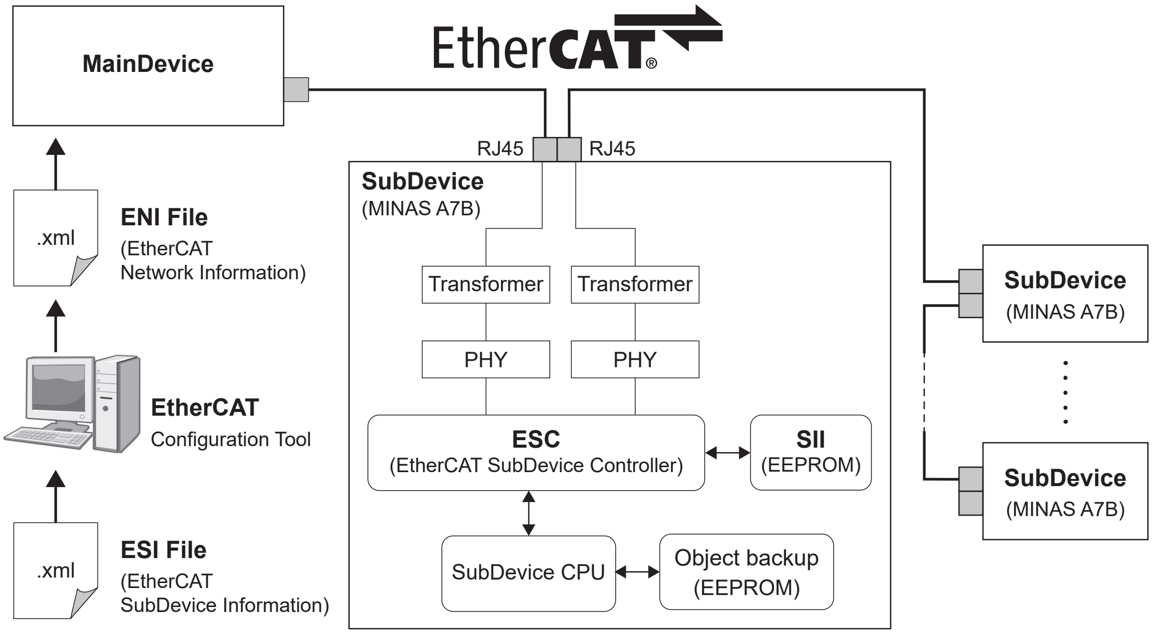
### 1.4.2 System Configuration

EtherCAT is a network system that connects a main device and multiple sub devices on a line.

Please contact us regarding non-line connections.

The number of potential node connections for a sub device depends on the processing and communication cycle of the main device, and on factors such as the number of bytes transmitted. Please also check the main device specifications.

The main device generates EtherCAT Network Information (ENI) based on EtherCAT Sub Device Information (ESI) we provide, and construct EtherCAT networks using ENI (using configuration tools).



- EtherCAT Sub Device Information (ESI)

  This is an XML-format file we provide.

  Download from our website.

  *https://industry.panasonic.com/global/en/*

  It lists definitions of fixed sub device information (including vendor data, product data, profile, object, process data, synchronization and SyncManager settings).

- EtherCAT Network Information (ENI)

  This is a file generated on the main device side.

ENI contains information (such as vendor data) to identify sub devices and to initialize each sub device. The main device initializes and constructs the network based on data contained in ENI.

- Sub device Information Interface (SII)

  EEPROM containing saved SII data is connected to the ESC.

  Data such as ESC initialization information, spec values for sub device application Communication Setting (mailbox data size values) and process data mapping is contained in the EEPROM (SII).

**— Precautions —**

- The cable length between nodes should be 100 m or less.
- This product does not support communication other than EtherCAT, for example the RTEX (Realtime Express) communication type MINAS A☐N Series cannot be connected.

  However, it can be connected to the EtherCAT communication type MINAS A☐B Series.
- When this product is rebooted, initialize EtherCAT communication and re-establish communication.

### 1.4.3 EtherCAT Reference Documents

This document has been created with reference to the following documents.

To the extent of any discrepancy between this document and the following reference documents, the descriptions in this document take precedence.

We do not guarantee all of the information in the reference materials that are not included in this document.

#### ■ EtherCAT standards

| Number | Document | Type | State | Version | Date |
|---|---|---|---|---|---|
| ETG.1000.2 | EtherCAT Specification - Part 2<br>- Physical Layer service definition and protocol specification | S | R | V1.0.4 | 2017/09/15 |
| ETG.1000.3 | EtherCAT Specification - Part 3<br>- Data Link Layer service definition | S | R | V1.0.4 | 2017/09/15 |
| ETG.1000.4 | EtherCAT Specification - Part 4<br>- Data Link Layer protocol specification | S | R | V1.0.4 | 2017/09/15 |
| ETG.1000.5 | EtherCAT Specification - Part 5<br>- Application Layer service definition | S | R | V1.0.4 | 2017/09/15 |
| ETG.1000.6 | EtherCAT Specification - Part 6<br>- Application Layer protocol specification | S | R | V1.0.4 | 2017/09/15 |
| ETG.1020 | Protocol Enhancements | S | R | V1.2.0 | 2015/12/01 |
| ETG.1300 | Indicator and Labeling | S | R | V1.1.1 | 2015/07/03 |
| ETG.2000 | Slave Information | S | R | V1.0.8 | 2016/09/20 |
| ETG.6010 | Implementation Directive for CiA402 Drive Profile | D | R | V1.1.0 | 2014/11/19 |

#### ■ CiA402 standards

| Number | Document | Type | State | Version | Date |
|---|---|---|---|---|---|
| IEC 61800-7-200<br>(201) | Adjustable speed electrical power drives systems<br>- Profile type 1 specification | — | — | Ed.1.0 | 2007/8/10 |
| IEC 61800-7-300<br>(301) | Adjustable speed electrical power drives systems<br>- Mapping of profile type 1 to network technologies | — | — | Ed.1.0 | 2007/8/10 |

#### ■ ESC register information

- PRU ICSS EtherCAT Sub Device Controller Register List

See the URL below. If a part number is specified, see AM64x information.

*https://software-dl.ti.com/processor-industrial-sw/esd/docs/indsw/EtherCAT_Slave/PRU_ICSS_EtherCAT_Slave_Controller_Register_List.html*

There are ET1100 non-compatible features. For details, see the URL below.

"2.5. Sitara TI ESC Exceptions"

*https://software-dl.ti.com/processor-industrial-sw/esd/docs/indsw/EtherCAT_Slave/Sitara_TI_ESC_Exceptions.html*

## 1.5 Software Version

### 1.5.1 Notes Regarding Software

This product incorporates open source software (OSS), and usage is pursuant to the terms of the license (see *"12.5 License Terms for Open Source Software (OSS)"* ). Your company may also have an obligation to use OSS, so please take appropriate measures at your company.

### 1.5.2 Applicable Software Version

The present manual applies to the following servo driver software versions.

| | |
|---|---|
| CPU 1 (Software version 1) | Ver.1.05 |
| CPU 2 (Software version 2) | Ver.1.02 |
| Manufacture Software (Software version 3) | Ver.1.01 |

### 1.5.3 Software Version Confirmation Method

The above software versions can be confirmed using the following methods.

- Software version 1, Software version 2
  - EtherCAT communication command Obj.3744h:00h "Software version"
    (See *"6.3.1 Device Information"* )
  - Set-up Support Software (PANATERM ver.7)
- Software version 3
  - EtherCAT communication command Obj.100Ah:00h "Manufacturer software version"
    (See *"6.3.1 Device Information"* )
  - Set-up Support Software (PANATERM ver.7)

### 1.5.4 Functions Not Currently Supported

The functions listed in the table below are not currently supported in this software version.

Please note that although the following functions are described in some parts of the text, they are not supported in this software version.

| Function name |
|---|
| Batteryless encoder |
| Full-closed control function (rotary scale) |
| Virtual full-closed control function |
| Deterioration diagnosis warning function |
| Retracting operation function |
| EoE (Ethernet over EtherCAT) |
| Touch probe function<br>● External scale z-phase latch function for semi-closed control |
| Backlash compensation function |

## 1.5.5 Restrictions

The functions below are not compatible with this software version.

The descriptions and notes regarding the following functions in the text are subject to change without prior notice.

| Item | Not currently compatible |
|---|---|
| Device profile | FoE (File Access over EtherCAT) |
| Modes of Operation (Control modes) | Interpolated position control/ip mode |
| Motion | Jerk |
| SDO message | Complete Access |

## 1.5.6 Software Version History

- New software versions are upward compatible with old software versions.

  The parameters used in the old software version can be used as they are in the new software version.

  Parameter factory default values for features added in the new software version are set to values that disable the added features. For this reason, immediately after upgrading, the servo driver will operate in a manner compatible with an older software versions.
- When using the added functions, set parameters in accordance with the explanations of functions in this manual.

| Software version | | Class | Changed Function Details | Relevant Section | Supported Set-up Support Software (PANATERM ver.7) |
|---|---|---|---|---|---|
| CPU1 | CPU2 | | | | |
| 1.04 | 1.02 | First version | Newly created | — | 7.0.0.0 and later |
| 1.05 | 1.02 | Extended Version 1 | Monitor Signal Output | *“3.2.8.1”* | 7.0.3.0 and later |
| | | | Position Comparison Output Function | *“8.3”* | |
| | | | EtherCAT communication Enhancements | *“4.2.2”* , *“10.2.3”*<br>TR_CS “1.2.7” | |

## 1.5.7 Functional Differences from Previous Series

- For differences from the MINAS A6B Series, see Technical Reference Functional Specification “1.2.6 Functional Differences from Previous Series” and Technical Reference Communication Specification “1.2.7 Functional Differences from Previous Series” .
- The MINAS A7B Series may not operate in complete compatibility with previous series (the A6B Series, etc.). Be sure to carry out an evaluation before changing from a previous series to the MINAS A7B Series, as parameter re-tuning may be required.

  The initial values for the MINAS A7B Series are listed in *“6.2 Object Dictionary List”* .

## 1.6 Trademarks

- MINAS, TUNE COMPASS and PANATERM are registered trademarks or trademarks of Panasonic Holdings Corporation in Japan and other countries.
- EtherCAT is a registered trademark and patented technology licensed by Beckhoff Automation GmbH, Germany.

## 1.7 Maintenance and Inspection

Routine maintenance and inspection of the driver and motor are essential for proper and safe operation.

### 1.7.1 Maintenance and Inspection Requests

- Power should be turned on and off by the operators themselves. Do not approach the motor or the machine when it is running during power-up to ensure safety in the event of an unexpected malfunction.
- After the power supply is switched off, the internal circuit is charged at high voltage for a period of time. Turn off the power and allow 15 minutes or longer after the charge lamp display on the front panel has gone off before inspection.
- Disconnect all connections to the driver when a performing a Megger test (insulation resistance measurement) of the driver. Performing a Megger test while it is connected may cause the driver to malfunction.
- Do not use benzine, thinner, alcohol, acidic, or alkaline detergents, since this may cause discoloration or damage the exterior of the product.

### 1.7.2 Inspection Items and Cycles

- Ordinary, normal usage conditions are indicated below.

  Condition range: Ambient temperature 30°C (annual average), load factor 80% or lower, operating hours 20 hours or less per day
- Perform daily and periodic inspections per the items below.

| Classification | Inspection Cycle | Inspection Item |
|---|---|---|
| Daily inspection | Daily | ● Are the operating temperature and humidity within the guaranteed range?<br>● Is there dirt, dust, and foreign matter?<br>● Is there any abnormal vibration or noise?<br>● Is the power supply voltage normal?<br>● Is there any unusual odor?<br>● Is there any lint or other particles adhering to air holes?<br>● Are the connector cables and the front portion of the driver clean?<br>● Is the wiring damaged?<br>● Are there loose connections or any misalignment between the motor and the machine or equipment?<br>● Is there any foreign matter caught on the load side? |
| Periodic inspection | Annual | ● Are there loose fasteners?<br>● Is there any evidence of overheating?<br>● Is the terminal block damaged?<br>● Are there loose fasteners on the terminal block? |

**— Precautions —**

- The periodic inspection cycle may change when the usage conditions change from the above.

### 1.7.3 Part Replacement

Part replacement cycles vary, depending on actual operating conditions. Parts must also be replaced (or repaired) when an error has occurred.

Some equipment may not be supported. Please address requests for parts or repairs to your dealer or motor repair consultation service.

**⚠ WARNING**

🚫 ● No disassembly and repair is to be performed except by Panasonic.

| Product Name | Classification | Approximate lifetime (hours) |
|---|---|---|
| Driver | Smoothing capacitor | Approximately 5 years |
| | Cooling fan (*1) | Approximately 2 years |
| | Aluminum electrolytic capacitor on the PCB | Approximately 5 years |
| | Inrush current preventive relay | Approximately 100,000 times<br>(Lifetime varies depending on usage conditions.) |
| | Inrush current preventive resistor | Approximately 20,000 times<br>(Lifetime varies depending on usage conditions.) |
| Motor | Bearing (*2) | 3 to 5 years (20,000 to 30,000 hours) |
| | Oil seal | 5000 hours |
| | Encoder | 3 to 5 years (20,000 to 30,000 hours) |
| | Battery for absolute encoder | See *“2.4.2 Battery for Absolute Encoder”* . |

*1 Only some models have internal cooling fans. For details, see *“2.1.2 Model Product Numbers”* .

*2 Bearing replacement requires disassembly of the motor.

When the motor is disassembled and reassembled, the precision of the flange surface perpendicularity to the shaft and shaft end flare cannot be guaranteed. Therefore, replacement and repair will only be performed with the customer's consent.

**Notes**

- The approximate lifetime is the number of years used for reference. Even before the approximate lifetime has elapsed, parts must be replaced if errors occur.
- If a driver or motor error occurs, replace the defective unit or replace with a new product (for parts other than cooling fan).

# 1.8 Compliance with International Standards

## 1.8.1 Conforming Standards

### 1.8.1.1 List of Conforming Standards

A list of conforming standards is shown below.

Multi-function type
Application specialized type

Standard type

**Servo Driver Conforming Standards**

| Conforming Standard Name | | Servo Driver |
|---|---|---|
| EU/UK Standards | EMC | EN 55011 (Group1, Class A)<br>EN 61000-6-2<br>EN 61000-6-4<br>EN 61800-3 (CategoryC2, Second environment) |
| | Low Voltage | EN 61800-5-1 |
| | Machinery<br>(Functional Safety) | EN ISO 13849-1:2015<br>EN 61508<br>EN IEC 62061<br>EN 61800-5-2<br>EN 61326-3-1<br>IEC 60204-1 |
| UL Standards | | UL 61800-5-1 (File No. E164620) |
| CSA Standards | | CSA C22.2 No. 274 |
| Radio Waves Act (South Korea) (KC) | | KN 11<br>KN 61000-4-2, 3, 4, 5, 6, 8, 11 |

**Safety Parameters**

| Parameters | With SSU diagnostic | With EDM diagnostic | With neither EDM nor SSU diagnostic |
|---|---|---|---|
| Safety integrity level | EN 61508 (SIL3)<br>EN IEC 62061 (maximum SIL 3) | EN 61508 (SIL3)<br>EN IEC 62061 (maximum SIL 3) | EN 61508 (SIL2)<br>EN IEC 62061 (maximum SIL 2) |
| Performance level | EN ISO 13849-1:2015<br>Category 3 PL e | EN ISO 13849-1:2015<br>Category 3 PL e | EN ISO 13849-1:2015<br>Category 3 PL d |
| Safety function | EN 61800-5-2 (SIL 3, STO) | EN 61800-5-2 (SIL 3, STO) | EN 61800-5-2 (SIL 2, STO) |
| Probability of dangerous failure per unit of time | PFH=0.88 ×$10^{-8}$ [1/h]<br>(% SIL3=8.8 %) | PFH=0.88 ×$10^{-8}$ [1/h]<br>(% SIL3=8.8 %) | PFH=0.91× $10^{-8}$ [1/h]<br>(% SIL2=0.91 %) |
| Average time to dangerous failure | MTTFd: High (100 years) | MTTFd: High (100 years) | MTTFd: High (100 years) |
| Average self-diagnosis coverage | DC: Medium 94.6 [%] | DC: Medium 94.6 [%] | DC: Low 68.1 [%] |
| Mission time | 15 years | 15 years | 15 years |
| Stop category | IEC 60204-1 (stop category 0) | IEC 60204-1 (stop category 0) | IEC 60204-1 (stop category 0) |

For details about diagnostics via SSU and EDM, see *"9.1.4 STO Function Diagnostics"* .

When exporting, follow the statutory provisions of the destination country.

**— Precautions —**

- The standard type does not support the functional safety standards.
- This product is not subject to China Compulsory Certification (CCC).

**AC Servo Motor Conforming Standards**

| | | Standard No. |
|---|---|---|
| EU/UK Standards | Low Voltage | EN 60034-1<br>EN 60034-5 |
| UL Standards | | UL 1004-1, UL 1004-6 (File No. E327868) |
| CSA Standards | | CSA 22.2, No. 100 |
| GB Standards (*1) | | GB 30253 |

*1 Models that meet this standard are those with 600 W or more and no brakes.

### 1.8.1.2 EU Directives and UK Regulations

Panasonic complies with the low voltage regulations of the EU and UK, in order to facilitate compliance of built-in equipment and devices with EU Directive/UK Regulations.

### 1.8.1.3 Compliance with EU Directives/UK Regulations

1. EN 55011

   Warning: Class A equipment is intended for use in an industrial environment. Conductive and radioactive interference can make it difficult to ensure electromagnetic compatibility in other environments.

   Note: This product is not intended for use in a residential environment, and protection against radio reception may be inadequate in such an environment.

2. EN 61800-3

   This product is not intended for ordinary home use, or for connection to low-voltage public communication circuits. Radio frequency interference may occur when connected to such circuits.

   In order to comply with EU EMC Directives and UK EMC Regulations, use a noise filter, a surge absorber, and a ferrite core. Compliance with EU EMC Directives and UK EMC Regulations must be confirmed using final equipment and devices with built-in servo drivers and servo motors.

### 1.8.1.4 Compliance with UL Standards

1. Installation Environment

   Use in an environment with a pollution degree of 2 as stipulated in IEC 60664-1.

   Make sure to connect a UL-approved (with LISTED mark) molded-case circuit-breaker (MCCB) and fuse to the main power supply.

   Only use copper conductor wires with a temperature rating of 75°C for wiring.

2. Short-Circuit Current Rating (SCCR)

   The servo driver of this product is compatible with power supplies with a symmetrical current of 5000 Arms or less at less than the maximum input voltage of the product.

3. Branch Circuit Protection

   Implement branch circuit protection in accordance with National Electrical Code (NEC) standards and local standards.

### 1.8.1.5 Support for SEMI F47 Momentary Power Failure Standard

The SEMI F47 standard includes requirements for voltage drops in semiconductor manufacturing equipment.

The control power supply for the servo driver complies with the SEMI F47 standard. The main circuit power supply complies with the SEMI F47 standard with no load or light loads.

**— Precautions —**

- The single phase 100 V specification servo driver is excluded.
- Always use the actual equipment for evaluation and review with respect to the SEMI F47 standard.

### 1.8.1.6 Radio Waves Act (South Korea) (KC)

The servo driver in this product is Class A device (broadcast communication device for business use) under the South Korea Radio Waves Act.

Please be aware of the following precautions before using this product.

A 급 기기 (업무용 방송통신기자재)

이 기기는 업무용(A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

( 대상기종 : Servo Driver )

[Reference translation]

Class A device (broadcast communication device for business use)

This device is an electromagnetic wave generating device for business use (Class A),

and is intended for non-household use.

Users and distributors should note this fact.

(Applicable model: Servo Driver)

### 1.8.1.7 Compliance with China RoHS

Hazardous material content information (English, Chinese)

**AC Servo Driver**

Applicable models and components

| | Applicable models | Components | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Printed circuit board | Heat sink | Plastic case | Screw | Fan | Cable | Accessory plug |
| A7 series | MADN∗∗∗∗∗∗∗∗ | ● | ● | ● | ● | — | — | ● |
| | MBDN∗∗∗∗∗∗∗∗ | ● | ● | ● | ● | — | — | ● |
| | MCDN205∗∗∗∗∗ | ● | ● | ● | ● | — | ● | ● |
| | MCDN245∗∗∗∗∗ | ● | ● | ● | ● | ● | ● | ● |
| | MDDN∗∗∗∗∗∗∗∗ | ● | ● | ● | ● | ● | ● | ● |
| ● : With components —: Without components | | | | | | | | |

Name and content of hazardous material in a product

| Name of component | Hazardous material | | | | | |
|---|---|---|---|---|---|---|
| | Lead (Pb) | Mercury (Hg) | Cadmium (Cd) | Hexavalent chromium (Cr (VI)) | Polybrominated biphenyl (PBB) | Polybrominated diphenyl ether (PBDE) |
| Printed circuit board | × | ○ | ○ | ○ | ○ | ○ |
| Heat sink | ○ | ○ | ○ | ○ | ○ | ○ |
| Plastic case | ○ | ○ | ○ | ○ | ○ | ○ |
| Screw | ○ | ○ | ○ | ○ | ○ | ○ |
| Fan | × | ○ | ○ | ○ | ○ | ○ |
| Cable | ○ | ○ | ○ | ○ | ○ | ○ |
| Accessory plug | ○ | ○ | ○ | ○ | ○ | ○ |
| This table is prepared based on the rules specified in SJ/T11364.<br>○ : The amount of hazardous materials in materials of all applicable components does not exceed the limit specified in GB/T26572.<br>× : The amount of hazardous material in the material of at least one of applicable components exceeds the limit specified in GB/T26572. | | | | | | |

## 交流伺服驱动器

对象机型及构成部位

| | 型号 | 构成部位 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 印刷电路板完成品 | 散热器 | 树脂机箱 | 螺丝 | 风扇 | 配线类 | 附带连接器 |
| A7 系列 | MADN＊＊＊＊＊＊＊＊ | ● | ● | ● | ● | — | — | ● |
| | MBDN＊＊＊＊＊＊＊＊ | ● | ● | ● | ● | — | — | ● |
| | MCDN205＊＊＊＊＊ | ● | ● | ● | ● | — | ● | ● |
| | MCDN245＊＊＊＊＊ | ● | ● | ● | ● | ● | ● | ● |
| | MDDN＊＊＊＊＊＊＊＊ | ● | ● | ● | ● | ● | ● | ● |
| ● : 有构成部位　— : 无构成部位 | | | | | | | | |

产品中有害物质的名称及含量

| 部件名称 | 有害物质 | | | | | |
|---|---|---|---|---|---|---|
| | 铅 (Pb) | 汞 (Hg) | 镉 (Cd) | 六价铬 (Cr (VI)) | 多溴联苯 (PBB) | 多溴二苯醚 (PBDE) |
| 印刷电路板完成品 | × | ○ | ○ | ○ | ○ | ○ |
| 散热器 | ○ | ○ | ○ | ○ | ○ | ○ |
| 树脂机箱 | ○ | ○ | ○ | ○ | ○ | ○ |
| 螺丝 | ○ | ○ | ○ | ○ | ○ | ○ |
| 风扇 | × | ○ | ○ | ○ | ○ | ○ |
| 配线类 | ○ | ○ | ○ | ○ | ○ | ○ |
| 附带连接器 | ○ | ○ | ○ | ○ | ○ | ○ |
| 本表格依据 SJ/T11364 的规定编制。<br>○ : 表示该有害物质在该部件所有均质材料中的含量均在 GB/T26572 规定的限量要求以下。<br>× : 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T26572 规定的限量要求。 | | | | | | |

**AC Servo Motor**

Applicable models and components

|  | Applicable models | Components |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Frame | Stator Assembly | Rotor Assembly | Bracket | Rotary Encoder | Screw | Resin parts | Metal parts |
| A7 series | M∗MG∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ | ● | ● | ● | ● | ● | ● | ● | ● |
| ● : With components　— : Without components |  |  |  |  |  |  |  |  |  |

Name and content of hazardous material in a product

| Name of component | Hazardous material |  |  |  |  |  |
|---|---|---|---|---|---|---|
|  | Lead (Pb) | Mercury (Hg) | Cadmium (Cd) | Hexavalent chromium (Cr (VI)) | Polybrominated biphenyl (PBB) | Polybrominated diphenyl ether (PBDE) |
| Frame | × | ○ | ○ | ○ | ○ | ○ |
| Stator Assembly | × | ○ | ○ | ○ | ○ | ○ |
| Rotor Assembly | × | ○ | ○ | ○ | ○ | ○ |
| Bracket | × | ○ | ○ | ○ | ○ | ○ |
| Rotary Encoder | × | ○ | ○ | ○ | ○ | ○ |
| Screw | ○ | ○ | ○ | ○ | ○ | ○ |
| Resin Parts | ○ | ○ | ○ | ○ | ○ | ○ |
| Metal Parts | × | ○ | ○ | ○ | ○ | ○ |

This table is prepared based on the rules specified in SJ/T11364.
○ : The amount of hazardous materials in materials of all applicable components does not exceed the limit specified in GB/T26572.
× : The amount of hazardous material in the material of at least one of applicable components exceeds the limit specified in GB/T26572.

## 交流伺服电机

对象机型及构成部位

| | 型号 | 构成部位 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 架 | 定子组装 | 转子组装 | 托架 | 编码器 | 螺丝 | 树脂零件 | 金属零件 |
| A7 系列 | M*MG******** | ● | ● | ● | ● | ● | ● | ● | ● |
| ● : 有构成部位　— : 无构成部位 | | | | | | | | | |

产品中有害物质的名称及含量

| 部件名称 | 有害物质 | | | | | |
|---|---|---|---|---|---|---|
| | 铅 (Pb) | 汞 (Hg) | 镉 (Cd) | 六价铬 (Cr (VI)) | 多溴联苯 (PBB) | 多溴二苯醚 (PBDE) |
| 架 | × | ○ | ○ | ○ | ○ | ○ |
| 定子组装 | × | ○ | ○ | ○ | ○ | ○ |
| 转子组装 | × | ○ | ○ | ○ | ○ | ○ |
| 托架 | × | ○ | ○ | ○ | ○ | ○ |
| 编码器 | × | ○ | ○ | ○ | ○ | ○ |
| 螺丝 | ○ | ○ | ○ | ○ | ○ | ○ |
| 树脂零件 | ○ | ○ | ○ | ○ | ○ | ○ |
| 金属零件 | × | ○ | ○ | ○ | ○ | ○ |
| 本表格依据 SJ/T11364 的规定编制。<br>○ : 表示该有害物质在该部件所有均质材料中的含量均在 GB/T26572 规定的限量要求以下。<br>× : 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T26572 规定的限量要求。 | | | | | | |

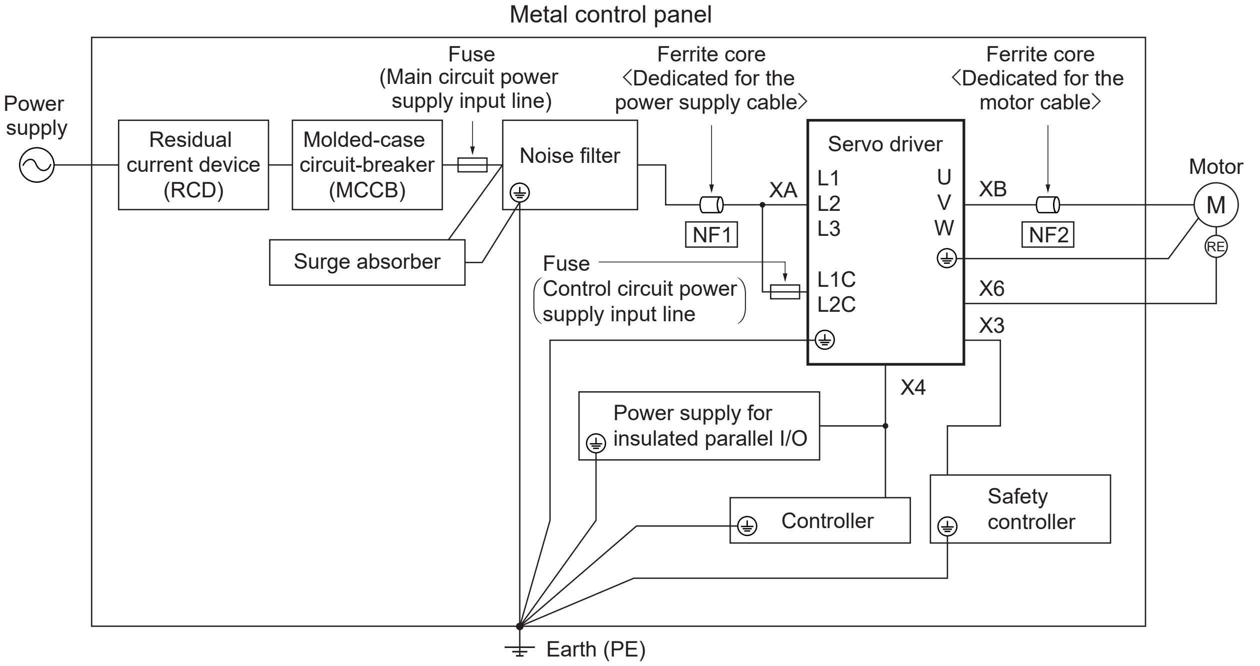
## 1.8.2 Configuration of Peripheral Devices

### 1.8.2.1 Installation Environment

- Use in an environment with a pollution degree of 2 as stipulated in IEC 60664-1.
  (Example) Installation in an IP54 metal control panel.
- Make sure to connect an IEC Standard and UL-approved (with LISTED mark) molded-case circuit-breaker (MCCB) and fuse to the main power supply.
- Use a 24 V DC power supply with double insulation or reinforced insulation for the parallel I/O power supply.

**Example installation in a metal control panel**

100 V/200 V System specifications



The conditions required for compliance with EU EMC Directive/UK EMC Regulations are indicated below.

- Install the servo driver on the metallic casing (control panel).
- Install a noise filter and surge absorber in the power supply line.
- Shielded twisted-pair cables must be used for input/output signal cables and encoder cables. Use tin plated annealed copper wire for the shield.
- Provide a ferrite core, according to the diagram, for each power source cable and motor cable to be connected to the servo driver.
- Cable shields (not shown in the diagram) should be directly grounded to protective earth (PE).

The foregoing are conditions for compliance with EU EMC Directives and UK EMC Regulations, and since installation and wiring conditions are affected by the statuses of connected devices and wiring when incorporated into the equipment used, compatibility with all devices must be confirmed.

**Notes**

- For details on the structures of the wires, cables, peripheral devices, and control panel in the above diagram, see *“1.8.2.2 List of Peripheral Devices”* to *“1.8.2.14 Overload Protection and Overheating Protection”* from the next section onwards.

**— Precautions —**

- Use the parts correctly after reading the respective operating instructions for each, and sufficiently reviewing the precautions. Also, ensure that excessive stress is not applied to the parts.

### 1.8.2.2 List of Peripheral Devices

Peripheral devices used together with the servo driver, as well as device installation methods, methods of use, and installation precautions are indicated below. For an installation example, see *"1.8.2.1 Installation Environment"* .

| Servo Driver (*1) | Voltage Specification | Motor rated output | Power Supply Capacity (At rated load) | Molded-case Circuit-Breaker (MCCB) Rated Current | Short protection element (fuse) | | Noise filter (*3) | Surge absorber (*3) | Ferrite core (*3) | | Electromagnetic Contactor (Rated carrying current/Open thermal current) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Main circuit power supply input line | Control circuit power supply input line | | | Power Supply Cable | Motor cable | |
| MADN061☐☐ | Single phase 100 V | 50 W | Approx. 0.4 kVA | 15 A | 10 A | 1 A | DV0P4170 | RSPD-250-Q4 | — | DV0P1460 | 20 A |
| MADN081☐☐ | | 100 W | Approx. 0.4 kVA | | | | | | — | | |
| MBDN121☐☐ | | 200 W | Approx. 0.5 kVA | | | | | | — | | |
| MCDN201☐☐ | | 400 W | Approx. 0.9 kVA | | 20 A | | DV0PM20042 | | — | | |
| MADN065☐☐ | Single phase/3-phase 200 V | 50 W | Approx. 0.5 kVA | | 10 A | | DV0P4170 (for single phase) / DV0PM20042 (for 3-phase) | RSPD-250-Q4 (for single phase) / RSPD-250-U4 (for 3-phase) | — | | |
| | | 100 W | | | | | | | — | | |
| MADN085☐☐ | | 200 W | Approx. 0.6 kVA | | | | | | — | | |
| MBDN125☐☐ | | 400 W | Approx. 1.0 kVA | | | | | | — | | |
| MCDN205☐☐ | | 750 W | Approx. 1.9 kVA | | 20 A | | DV0PM20042 | | — | | |
| MDDN405☐☐ (*2) | | 1000 W | Approx. 2.4 kVA | | 35 A | | DV0P4220 | | — | | 32 A |

*1 The "☐" in the model number represents the difference in specification.

*2 When using a single-phase power supply, the driver input RMS current must be derated to 12 Arms or less for UL certification.

*3

| | Optional Product Number | Manufacturer Product Number | Manufacturer |
|---|---|---|---|
| Surge absorber | — | RSPD-250-U4 | Okaya Electric Industries |
| | — | RSPD-250-Q4 | |
| Ferrite core | DV0P1460 | ZCAT3035-1330 | TDK Corporation |
| Noise filter | DV0P4170 | SUP-EK5-ER-6 | Okaya Electric Industries |
| | DV0P4220 | 3SUP-HU30-ER-6 | |
| | DV0PM20042 | 3SUP-HU10-ER-6 | |

**Notes**

- For models with single-phase/3-phase 200 V specifications, select the peripheral devices according to the power source used.
- For details on servo driver product numbers, see *"How to Read Product Numbers"* and *"2.1.2 Model Product Numbers"* .
- For details on peripheral device specifications, see *"12.4 Optional Parts"* .

**— Precautions —**

- Select a molded-case circuit-breaker (MCCB) noise filter with a capacity that matches the power supply capacity (considering load conditions).
- Earth terminal

  Use copper conductor wires with a temperature rating of 75°C or higher for wiring.

  Protective earth terminals are M4 for sizes A to D.
- The wire diameter of the earth wire cable should be 2.0 mm$^2$ (AWG 14) or more for outputs of 50 W to 2.5 kW, 3.5 mm$^2$ (AWG 12) or more for outputs of 3.0 kW to 5.0 kW, 8.0 mm$^2$ (AWG 8) or more for 7.5 kW, 22 mm$^2$ (AWG 4) or more for 15.0 kW, and 38 mm$^2$ (AWG 2) or more for 22.0 kW.
- For sizes A to D, use the included dedicated connectors.
- The tightening torque of the screws used for connecting the host controller to connector X4 should be 0.2 ± 0.05 N·m.

  The servo driver-side connector may break if you exceed the maximum screw tightening torque.

### 1.8.2.3 Electric Wires

#### 1.8.2.3.1 Wires and Maximum Cable Length

| Name | Symbol | Maximum Cable Length (*1) | Wires Used |
|---|---|---|---|
| Main power supply input | L1, L2, L3 | – | See *“1.8.2.3.2 Wire Specifications by Model”* . |
| Control power supply input | L1C, L2C | – | |
| Motor output | U, V, W, ⏚ | 20 m | |
| Earth cable | ⏚ | – | |
| Encoder connection | X6 | 10 m | Shielded twisted-pair wire<br>0.18 mm$^2$ or larger cross-sectional area of core wire |
| External scale connection (*3) | X5 | 20 m | |
| Parallel I/O connection | X4 | 3 m | |
| Safety connection (*3) | X3 | 3 m | 0.18 mm$^2$ or larger cross-sectional area of core wire |
| EtherCAT connection | X2 | 100 m (*2) | TIA/EIA-568 CAT5e STP |

*1 The above wiring lengths are the maximum lengths used in Panasonic's evaluation environment, and do not guarantee operation in customers’ operating environments.

*2 For details, see *“3.2.3 Wiring to Connector X2 (Host Device Connection)”* .

*3 Compatible with both the multi-function type and application specialized type. For supported functions by driver type, see *“2.1.4.5 Supported Functions (By Driver Type)”* .

### 1.8.2.3.2 Wire Specifications by Model

| Servo Driver | Applicable motors | Voltage Specification | Motor rated output | Power Supply Capacity (At rated load) | Main circuit wire diameter/ Withstand voltage | Control power wire diameter/ Withstand voltage | Motor wire diameter/ Withstand voltage | Brake wire diameter/ Withstand voltage | Earth wire diameter/ Withstand voltage |
|---|---|---|---|---|---|---|---|---|---|
| MADN061□□ | MHMG5AZU1□2□ | Single phase 100 V | 50 W | Approx. 0.4 kVA | 2.0 mm$^2$/<br>AWG 14<br>300 V or more | 2.0 mm$^2$/<br>AWG 14<br>300 V or more | 0.75 mm$^2$/<br>AWG 18<br>300 V or more | 0.75 mm$^2$/<br>AWG18<br>100 V or more | 2.0 mm$^2$/<br>AWG 14<br>300 V or more |
| MADN081□□ | MHMG011U1□2□ | | 100 W | Approx. 0.4 kVA | | | | | |
| MBDN121□□ | MHMG021U1□2□ | | 200 W | Approx. 0.5 kVA | | | | | |
| MCDN201□□ | MHMG041U1□2□ | | 400 W | Approx. 0.9 kVA | | | | | |
| MADN065□□ | MHMG5AZU1□2□ | Single phase/ 3-phase 200 V | 50 W | Approx. 0.5 kVA | | | | | |
| | MHMG012U1□2□ | | 100 W | | | | | | |
| MADN085□□ | MHMG022U1□2□ | | 200 W | Approx. 0.6 kVA | | | | | |
| MBDN125□□ | MHMG042U1□2□ | | 400 W | Approx. 1.0 kVA | | | | | |
| MCDN205□□ | MHMG082U1□2□ | | 750 W | Approx. 1.9 kVA | | | | | |
| MDDN405□□ | MHMG092U1□2□ | | 1000 W | Approx. 2.4 kVA | | | 1.25 mm$^2$/<br>AWG16<br>300 V or more | | |

**Notes**

- Select the peripheral devices for both single phase and 3-phase 200 V specifications according to the power supply used.

### 1.8.2.3.3 Wiring Terminal Blocks and Earth Terminals

- Use copper conductor wires with a temperature rating of 75°C or higher for wiring.
- Ensure that the product is wired correctly and securely. Insecure or improper wiring may cause the motor to run out of control or burn.

  Ensure that no conductive material such as wire debris enters into the servo driver during installation and wiring.
- For sizes A to D, use the included dedicated connectors. For wiring methods, see *"3.2.1.3 Wiring the Driver XA, XB Connectors"* and *"3.2.1.4 Motor Connector Specifications"* .
- The tightening torque is indicated below.

  When connecting the ground screw to the host controller with a connector (X4)

| Servo Driver Size | Ground Screw | | Connector (X4) for Connecting to Host Controller | |
|---|---|---|---|---|
| | Nominal | Tightening Torque [N·m] | Nominal | Tightening Torque [N·m] |
| A to D | M4 | 0.7 to 0.8 | M2.6 | 0.2 ± 0.05 |

**— Precautions —**

- Exceeding the maximum tightening torque may cause damage.
- Do not turn on the power with the terminal block screws loose. Turning on the power with screws loose may cause smoke emission or fire.

- Conduct annual periodic inspections of tightening torque to check for looseness and retighten so that the tightening torque is within the specified range as necessary.

#### 1.8.2.3.4 Relationship Between Cable Thickness and Allowable Current

An example of the relationship between cable diameter and allowable current is provided below. Refer to this when selecting cables.

(Example) When used with the conditions of a 3-phase 200 V power supply circuit, 35 A current, and 30°C ambient temperature

1. Select the fundamental allowable current in accordance with the wire material used in the cable (stranded copper wire in the example).

   (Select ◇ in the table of basic current capacity)

2. After selecting the fundamental allowable current, determine the number of wires to be used. A 4-core cable is selected, consisting of 3-phase wire (3 wires) and a ground wire, but the number of wires is 3 because the ground wire is not counted (◎ in the current reduction coefficient table).

3. When the usage conditions have been selected, determine the actual allowable current from the following formula.

   Implemented allowable current

   = fundamental allowable current × current reduction coefficient × current compensation coefficient

   $= 37 \times 0.7 \times 1.414$

   $\cong 36.6$ (A) as the result.

   - The current compensation coefficient can be calculated from the following formula.

     $\sqrt{(\text{Max. allowable temperature} - \text{ambient temperature}) \div 30}$

     Check the specifications for the cable used, since the current compensation coefficient varies, depending on the cable.

   - The current reduction coefficient is provided for cases in which the cable (4-conductor cable in the example), is housed in a plastic sheath, plastic tube, metal sheath, metal tube, or flexible conduit.

4. The current used in the cables is 35 A, which is within the allowable range, and therefore, the cable used, having a nominal cross-sectional area 3.5 $\text{mm}^2$ larger than that of the table of recommended eco-cables, is a 4-core polyethylene-insulated power cable with heat-resistant polyethylene sheath, having a finished outer diameter of 13.5 mm (shielded, 14.5 mm).

**Notes**

- It is recommended that you take into account a margin for operation temperature, electric current, etc., when selecting cables for cable testing.
- The current reduction coefficient, fundamental allowable current, etc., indicated on this page may change depending on standards revisions, etc. Therefore, be sure to check with the manufacturer of the cable used in testing.

Fundamental allowable current

| Stranded conductor wire diameter (Nominal cross-sectional area, mm$^2$) | Copper wire [A] |
|---|---|
| ≥2 and <3.5 | 27 |
| ≥3.5 and <5.5 ◇ | 37 |
| ≥5.5 and <8 | 49 |
| ≥8 and <14 | 61 |
| ≥14 and <22 | 88 |
| ≥22 and <30 | 115 |
| ≥30 and <38 | 139 |
| ≥38 and <60 | 162 |
| ≥60 and <100 | 217 |
| ≥100 and <150 | 298 |
| ≥150 and <200 | 395 |

Current reduction coefficient

| Number of cables in the same tube | Current reduction coefficient |
|---|---|
| 3 wires or less ◎ | 0.70 |
| 4 wires | 0.63 |
| 5 or 6 wires | 0.56 |
| ≥7 wires and ≤15 wires | 0.49 |
| ≥16 wires and ≤40 wires | 0.43 |
| ≥41 wires and ≤60 wires | 0.39 |
| ≥61 wires | 0.34 |

## ■ Recommended eco-cables

Cable type: 4-core polyethylene-insulated power cable with heat-resistant polyethylene sheath (standard: “EM” JIS C 3605)
Maximum allowable temperature: 90°C

| Conductor | | | Insulation thickness [mm] | Sheath thickness [mm] | [Reference] Finished outer diameter [mm] | Maximum conductor resistance [20°C] [Ω/km] | Test voltage [V/minute] | Minimum insulation resistance [MΩ･km] | [Reference] Approximate mass [kg/km] |
|---|---|---|---|---|---|---|---|---|---|
| Nominal cross sectional area (mm$^2$) | Structure or shape (wires/ mm$^2$) | Outer diameter [mm] | | | | | | | |
| 2 | 7/0.6 | 1.8 | 0.8 | 1.5 | 12.0 | 9.42 | 1500 | 2500 | 170 |
| 3.5 | 7/0.8 | 2.4 | 0.8 | 1.5 | 13.5 | 5.30 | 1500 | 2500 | 250 |
| 5.5 | 7/1.0 | 3.0 | 1.0 | 1.5 | 16.0 | 3.40 | 1500 | 2500 | 360 |
| 8 | 7/1.2 | 3.6 | | | 17.0 | 2.36 | | 2000 | 475 |
| 14 | Circular compressed | 4.4 | | | 19.0 | 1.34 | 2000 | 1500 | 730 |
| 22 | | 5.5 | 1.2 | 1.6 | 23 | 0.849 | | | 1100 |
| 38 | | 7.3 | | 1.8 | 28 | 0.491 | 2500 | | 1800 |
| 60 | | 9.3 | 1.5 | 2.0 | 35 | 0.311 | | | 2790 |
| 100 | | 12.0 | 2.0 | 2.4 | 44 | 0.187 | | | 4630 |
| 150 | | 14.7 | | 2.6 | 51 | 0.124 | 3000 | 1000 | 6710 |
| 200 | | 17.0 | 2.5 | 2.9 | 60 | 0.0933 | | 1500 | 8990 |

* The finished shielded outer diameter is approximately 1 mm larger.

### 1.8.2.3.5 Movable Part Cable Wiring

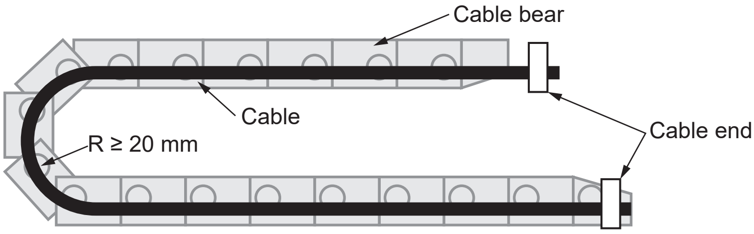
When wiring in a cable bear, please observe the following precautions.

1 Cable bear wiring

The bend radius of the cable must be 10 times or more its finished outer diameter. However, set the minimum radius to R ≥20 mm (for the finished outer diameter, see table *"1.8.2.3.4 Relationship Between Cable Thickness and Allowable Current"* above).

Do not affix or bundle wires in the cable bear. When securing the cable, affix it only at non-movable ends of the cable bear, at which the cable is free from any stress (e.g. tension). (The cable cannot be fixed rigidly.)

**Recommended cable bear wiring**



Do not keep the cable too long and loose or too short and tense.

Note that in this state the sheath may be cracked by the internal wall of the cable bear, entangled with other cables, etc., causing unexpected accidents.

2 Cable twisting

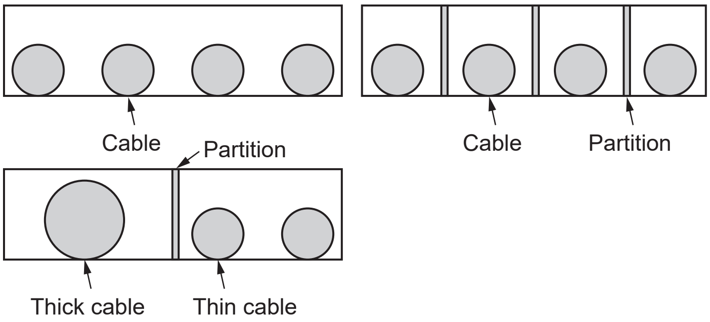
Do not twist the cable. Note that twisted cables may lead to poor contact, lowered performance of the cable from its original state, and declining reliability.

3 Cable bear interior cable space factor

Arrange the cables so as not to overlap horizontally, and select a cable bear of ample width.

Ensure that the cable space factor is 60% or less (30% or less is recommended). Do not run cables of greatly differing outer diameters together in mixed wiring. If cables of greatly differing outer diameters are run together in mixed wiring, thin cables may break under the pressure of thick cables. If mixing cables, provide a partition to separate them inside the cable bear.

**Example of wiring inside a cable bear**



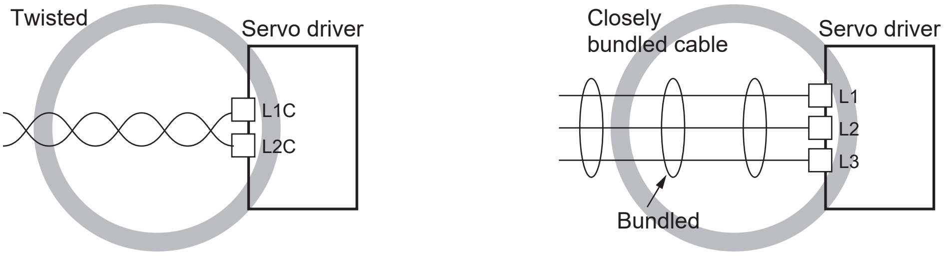
### 1.8.2.4 Power Supply

- Use this product in the Overvoltage Category III environment provided for in IEC 60664-1.
- Use a parallel I/O power supply product that is CE marking compliant or an insulated 12-24 V DC power supply that is EN standard (EN 60950) compliant.
- The power supply voltage specifications are as follows.

| Voltage | Servo Driver Size | Voltage Specification | Frequency |
|---|---|---|---|
| 100 V | A to C | Single phase: 100 to 120 V, -15% to +10% | 50/60 Hz |
| 200 V | A to D | Single phase/3-phase: 200 to 240 V, -15% to +10% | 50/60 Hz |

**— Precautions —**

- Power cable and signal wires must be isolated from each other in wiring.
- Use a sheathed (jacketed) cable, twisted cable (illustrated on the left below), or closely bundled cable (illustrated on the right below) for the power cable.



### 1.8.2.5 Molded-Case Circuit-Breaker (MCCB)

- In order to ensure compliance with EU Directives/UK Regulations, make sure to connect a molded-case circuit-breaker (MCCB) between the power supply and noise filter.

  The short-circuit current of the power supply used should be a symmetrical current of 5,000 Arms or less, at or below the maximum input voltage of the product.

  If the short-circuit current of the power supply exceeds this, limit the short-circuit current by using a current-limiting device (such as a current-limiting fuse, current-limiting breaker, transformer).
- The product's short-circuit protection circuit is not intended to protect branch circuits. Select branch circuit protection in accordance with the NEC standard and local standards.
- This product does not have earth fault protection functions. Please install a molded-case circuit-breaker or residual current device that corresponds to the corresponding earthing system.

  Earth fault protection conditions for when using a molded-case circuit-breaker are as shown below. These conditions satisfy the requirements of EN 60364-4-41.

| Servo driver | Molded-case circuit-breaker | | | Voltage to ground [V] | Maximum allowable fault loop impedance (Ω) |
|---|---|---|---|---|---|
| | Rating [A] | Recommended model | Manufacturer | | |
| MADN061□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 100 | 0.25 |
| MADN081□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 100 | 0.31 |
| MBDN121□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 100 | 0.31 |
| MCDN201□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 100 | 0.42 |
| MADN065□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 115 | 0.33 |
| MADN085□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 115 | 0.39 |
| MBDN125□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 115 | 0.42 |

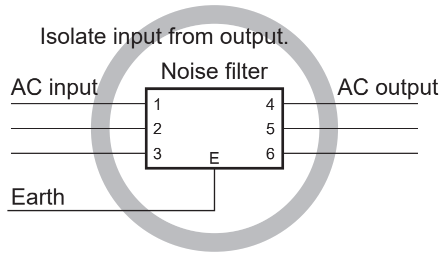
| Servo driver | Molded-case circuit-breaker | | | Voltage to ground [V] | Maximum allowable fault loop impedance (Ω) |
|---|---|---|---|---|---|
| | Rating [A] | Recommended model | Manufacturer | | |
| MCDN205□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 115 | 0.50 |
| MDDN405□□ | 15 | BW50RAGU | Fuji Electric Co., Ltd. | 115 | 0.51 |

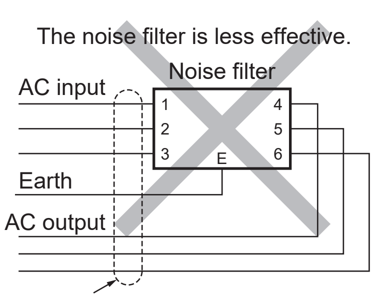
**Notes**

- Select a molded-case circuit-breaker (MCCB) with a capacity that matches the power supply capacity (considering load conditions).

### 1.8.2.6 Noise Filter

- Select a noise filter with a capacity that matches the power supply capacity (considering load conditions).
- For the detailed specifications of each noise filter, contact the manufacturer.
- Consult with the manufacturer of the noise filter if using multiple servo drivers and installing one noise filter for all power supplies.
- Noise immunity is reduced if the same wiring is used for input and output (Illustrated on the right below.).
- Isolate input from output (Illustrated on the left below.).


Isolate input from output.


The noise filter is less effective.

Do not put wires in the same duct or bind them together.

**Notes**

- For details of optional product numbers and specifications, see *“12.4.1 Noise Filter”* .

### 1.8.2.7 Surge Absorber

- Install the surge absorber on the primary side of the noise filter.
- For details of optional product numbers and specifications, see *“12.4.2 Surge Absorber”* .

**— Precautions —**

- Always remove the surge absorber before high voltage insulation testing machinery and equipment.
  Failure to do so may result in damage to the surge absorber.

### 1.8.2.8 Ferrite Core

- Ensure all cables (motor cables, encoder cables, interface cables, USB cables) have a ferrite core.

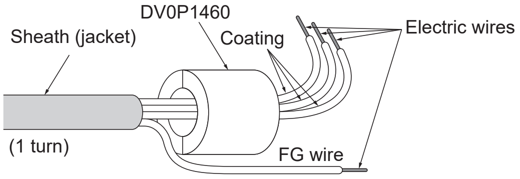
| Symbol (*1) | Place of use | Applicable size | Option product number | Manufacturer product number | Manufacturer | Number required |
|---|---|---|---|---|---|---|
| NF1 | Power supply cable | (100 V) A, B, C<br>(200 V) A, B, C, D | — | — | — | 0 |
| NF2 | Motor cable | (100 V) A, B, C<br>(200 V) A, B, C, D | DV0P1460 | ZCAT3035-1330 | TDK Corporation | 1 (*2) |

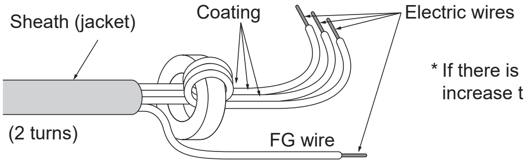
*1 For symbols, see *"1.8.2.1 Installation Environment"* .

*2 For ferrite cores, attach the motor cables (U, V, and W) together into a single unit using 1 turn (once through).

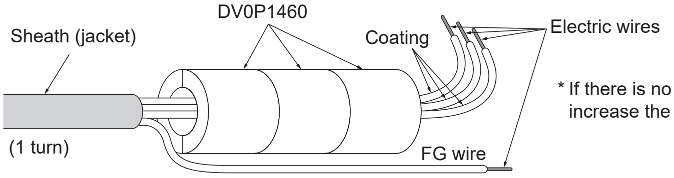
- Attach ferrite cores according to the following procedure.

| | |
|---|---|
| Signal cables | Wind the ferrite cores for the required number of turns. |
| Motor cable | When attaching ferrite cores (including those that are power line-dedicated) to Panasonic's optional cables, remove the sheaths (jackets) from the parts attached, and combine the motor cables (U, V, and W) to obtain a noise reducing effect.<br>If there is no effect, take measures such as increasing the number of ferrite cores (including those that are power line-dedicated) (See the figure below.). |
| Encoder wires | Wind the ferrite cores for the required number of turns. |





* If there is no effect, and fine wires are used, increase the number of turns.



* If there is no effect, and thick wires are used, increase the number of noise filters.

### 1.8.2.9 Residual Current Device

- Install a residual current device (RCD) on the primary side of the power supply.
- Use IEC 60947-2/JISC 8201-2-2 Type B (DC sensing type) for the residual current devices.
- This product does not have earth fault protection. Please install a molded-case circuit-breaker or residual current device that corresponds to the corresponding earthing system.

  Earth fault protection conditions for when using residual current devices are as shown below. These conditions satisfy the requirements of EN 60364-4-41.

  Ensure your TT system complies with your local national or regional laws and regulations. The rated sensed current and loop impedance of residual current devices may sometimes be stipulated by law or regulation. Further, Type B residual current devices may be mandatory.

| Servo driver | Residual current device | | | | Voltage to ground [V] | Maximum allowable loop impedance [Ω] |
|---|---|---|---|---|---|---|
| | Rating [A] | Rated sensed current [mA] | Recommended model | Manufacturer | | |
| MADN061☐☐ | 15 | 30 | EW50RAGU | Fuji Electric Co., Ltd. | 100 | 360 |
| MADN081☐☐ | 15 | 30 | EW50RAGU | Fuji Electric Co., Ltd. | 100 | 360 |
| MBDN121☐☐ | 15 | 30 | EW50RAGU | Fuji Electric Co., Ltd. | 100 | 360 |
| MCDN201☐☐ | 15 | 30 | EW50RAGU | Fuji Electric Co., Ltd. | 100 | 360 |
| MADN065☐☐ | 15 | 100 | EW50RAGU | Fuji Electric Co., Ltd. | 115 | 207 |
| MADN085☐☐ | 15 | 100 | EW50RAGU | Fuji Electric Co., Ltd. | 115 | 207 |
| MBDN125☐☐ | 15 | 100 | EW50RAGU | Fuji Electric Co., Ltd. | 115 | 207 |
| MCDN205☐☐ | 15 | 100 | EW50RAGU | Fuji Electric Co., Ltd. | 115 | 207 |
| MDDN405☐☐ | 15 | 100 | EW50RAGU | Fuji Electric Co., Ltd. | 115 | 207 |

### 1.8.2.10 Earth

- To prevent electric shock, make sure to connect the earth terminal (⏚) of the servo driver to the earth (PE) of the control panel.
- Do not tighten the connection to the protective earth terminal (⏚). Two earth terminals are provided.

### 1.8.2.11 Control Panel Structure

- If there is a gap at a cable inlet/outlet, the mounting hole of operation panel, a door, etc., radio waves may leak out of or penetrate into the control panel. In order to prevent this, please observe the following in designing or selecting the control panel.
  - The control board should be made of metal and ensure that it is electrically conductive.
  - The control board should not have electrically floating conductive parts.
  - The units mounted inside the case should be connected to the case.

### 1.8.2.12 Control Input/Output Signal Noise Immunity Enhancement

- When noise is introduced to the control input/output, it causes displacement and input/output signal malfunction.
  - Connectors X1 to X7 are used for the secondary circuit.

    The 24 V DC power supply for brakes requires insulation. Do not connect to the same power supply. Do not connect a ground wire. This may cause erroneous operation of the input/output signal.
  - The control power source should be completely isolated from external operating power sources. Take care not to connect the ground wire of the control power source to that of external power source.
  - Use a shielded cable as the signal cable, and earth both of the shielded ends.

### 1.8.2.13 Installing Short Protection Elements

- Connect fuses on the main circuit power supply input and control circuit power supply input lines. For details on fuse insertion locations, see below.
  - Sizes A, B: *"3.2.1.1.2 Example Connection for Entire Unit"* , *"3.2.1.1.3 Key Points on Wiring"*
  - Sizes C, D: *"3.2.1.2.2 Example Connection for Entire Unit"* , *"3.2.1.2.3 Key Points on Wiring"*
- Refer to the descriptions in the below table when selecting fuse rated currents. If compliance with UL61800-5-1 is required, use UL Listed fuses.

| Servo driver | Main circuit power supply input line fuse | | | | Control circuit power supply input line fuse | | | |
|---|---|---|---|---|---|---|---|---|
| | Rating | Options | | | Rating | Options | | |
| | | UL class | Recommended model | Manufacturer | | UL class | Product number | Manufacturer |
| MADN061□□ | 10 A | CC | LP-CC-10 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MADN081□□ | 10 A | CC | LP-CC-10 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MBDN121□□ | 10 A | CC | LP-CC-10 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MCDN201□□ | 20 A | CC | LP-CC-20 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MADN065□□ | 10 A | CC | LP-CC-10 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MADN085□□ | 10 A | CC | LP-CC-10 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MBDN125□□ | 10 A | CC | LP-CC-10 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MCDN205□□ | 20 A | CC | LP-CC-20 | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |
| MDDN405□□ | 35 A | J | LPJ-35SP | COOPER BUSSMANN LLC | 1 A | CC | LP-CC-1 | COOPER BUSSMANN LLC |

### 1.8.2.14 Overload Protection and Overheating Protection

- The servo driver has a built-in servo motor overload protection function. The overload protection function operates on the basis of specified time characteristics at 115% or more of the rated current.
- The servo motor does not have an overheating protection function. If NEC standard compliance is required, implement overheating protection measures for the servo motor.
- The servo driver is equipped with a thermal memory (shutdown) as required by EN 61800-5-1/UL 61800-5-1; however, it does not have thermal memory (power loss) or velocity sensor functions.

**Notes**

- For overload protection characteristics, see *"2.1.4.2 Overload Protection Time Characteristics (Driver)"* in *"2.1.4.1 Basic Specifications"* and *"2.2.5 Overload Protection Time Characteristics (Motor)"* .

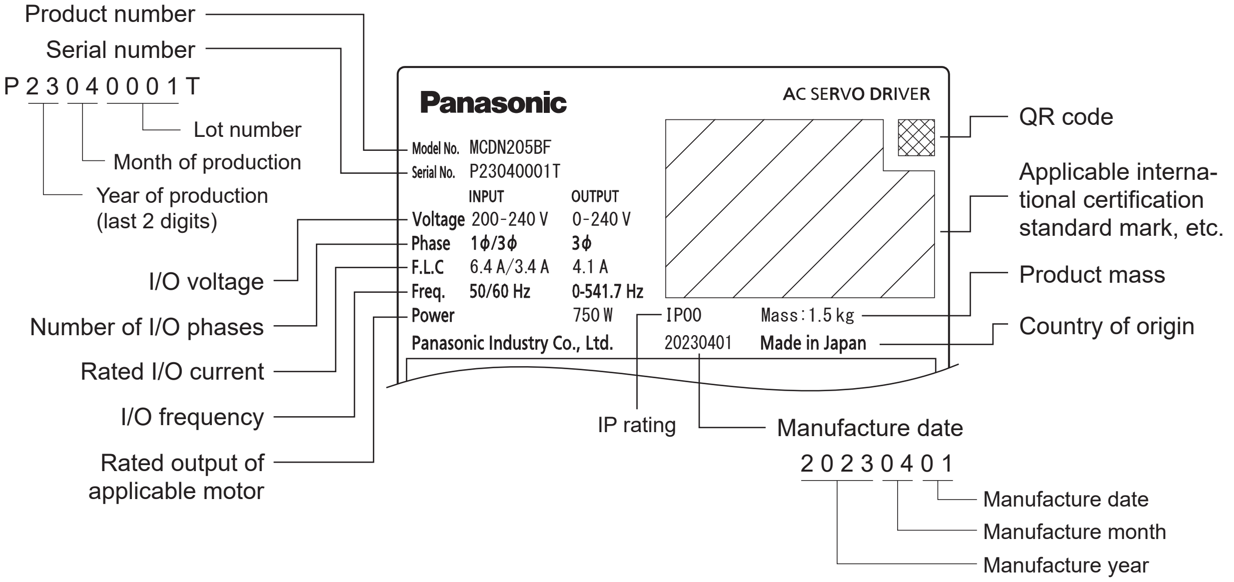
# 2 Driver and Motor Basic Specifications

## 2.1 Driver

### 2.1.1 Checking the Model

**Nameplate Example**

The details shown on nameplates are as shown below.



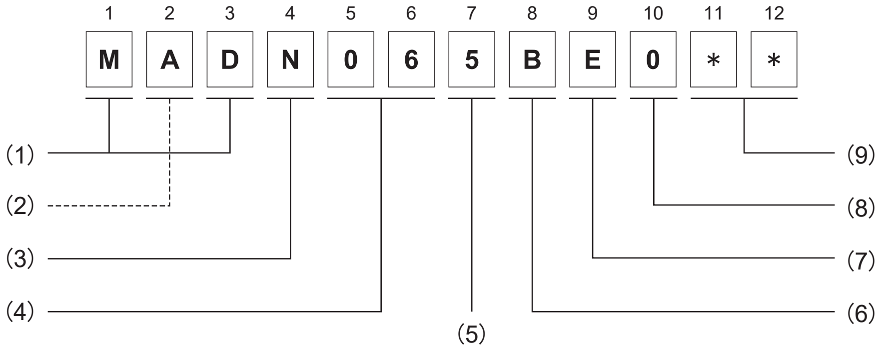
The range of the lot number in serial number is 1 to 33999, but the nameplate has 4 digits in the following format. In the four digits, the alphabet characters "I" (eye) and "O" (o) are not used.

| Value of serial number | Notation on the nameplate |
|---|---|
| 1 to 9999 | 0001 to 9999 |
| 10000 to 10999 | A000 to A999 |
| 11000 to 11999 | B000 to B999 |
| … | … |
| 17000 to 17999 | H000 to H999 |
| 18000 to 18999 | J000 to J999 |
| … | … |
| 22000 to 22999 | N000 to N999 |
| 23000 to 23999 | P000 to P999 |
| … | … |
| 33000 to 33999 | Z000 to Z999 |

## How to Read Product Numbers

The following explains how to read product numbers.

### Sample description



| No. | Item | Symbol | Specifications | Remarks |
|---|---|---|---|---|
| (1) | Product | M☐D | Servo Driver | ☐ = size symbol |
| (2) | Servo Driver Size | A | Size A | — |
| | | B | Size B | |
| | | C | Size C | |
| | | D | Size D | |
| (3) | Family | N | A7 Family | — |
| (4) | Instantaneous maximum current (peak value) | 06 | 6 A | — |
| | | 08 | 8 A | |
| | | 12 | 12 A | |
| | | 20 | 20 A | |
| | | 40 | 40 A | |
| (5) | Power supply and voltage specifications | 1 | Single phase 100 V | — |
| | | 5 | Single phase/3-phase 200 V | |
| (6) | Command interface specification | B | EtherCAT | — |
| (7) | Functionality | E | Rotation type Standard type<br>No Safety | — |
| | | F | Rotation type Multi-function type<br>Safety STO | |
| | | R | Rotation type Application specialized type<br>Safety STO | |
| (8) | Special product supported | 0 | Standard type, multi-function type special product | — |
| | | H | Gantry control supported | |
| | | T | Pressure control supported | |
| | | U | Meandering control, GAP control supported | |
| (9) | Special specifications | ** | — | Alphanumerics |

## 2.1.2 Model Product Numbers

### 2.1.2.1 Standard Type

| Product number | Product Code [*1] | Size symbol | Power supply input | Rated output of applicable motor | Built-in fan |
|---|---|---|---|---|---|
| MADN061BE | 70380000 | A | Single-phase 100–120 V | Max 50 W | No |
| MADN081BE | 70380001 | | | Max 100 W | No |
| MADN065BE | 70380004 | | Single-phase/3-phase 200–240 V | Max 100 W | No |
| MADN085BE | 70380005 | | | Max 200 W | No |
| MBDN121BE | 70380002 | B | Single-phase 100–120 V | Max 200 W | No |
| MBDN125BE | 70380006 | | Single-phase/3-phase 200–240 V | Max 400 W | No |
| MCDN201BE | 7038004F | C | Single-phase 100–120 V | Max 400 W | No |
| MCDN205BE | 70380050 | | Single-phase/3-phase 200–240 V | Max 750 W | No |
| MDDN405BE | 70380009 | D | Single-phase/3-phase 200–240 V | Max 1000 W | Provided |

*1 This is the product code for our servo driver listed in the ESI file (Hexadecimal notation).

* For servo driver and motor combinations, see *“2.3 Driver and Motor Combinations”* . Some motors cannot be used even if they match the rated outputs shown in this table.

### 2.1.2.2 Multi-function Type

| Product number | Product Code [*1] | Size symbol | Power supply input | Rated output of applicable motor | Built-in fan |
|---|---|---|---|---|---|
| MADN061BF | 713C0000 | A | Single-phase 100–120 V | Max 50 W | No |
| MADN081BF | 713C0001 | | | Max 100 W | No |
| MADN065BF | 713C0004 | | Single-phase/3-phase 200–240 V | Max 100 W | No |
| MADN085BF | 713C0005 | | | Max 200 W | No |
| MBDN121BF | 713C0002 | B | Single-phase 100–120 V | Max 200 W | No |
| MBDN125BF | 713C0006 | | Single-phase/3-phase 200–240 V | Max 400 W | No |
| MCDN201BF | 713C004F | C | Single-phase 100–120 V | Max 400 W | No |
| MCDN205BF | 713C0050 | | Single-phase/3-phase 200–240 V | Max 750 W | No |
| MDDN405BF | 713C0009 | D | Single-phase/3-phase 200–240 V | Max 1000 W | Provided |

*1 This is the product code for our servo driver listed in the ESI file (Hexadecimal notation).

* For servo driver and motor combinations, see *“2.3 Driver and Motor Combinations”* . Some motors cannot be used even if they match the rated outputs shown in this table.

### 2.1.2.3 Application specialized Type

| Product number | Product Code (*1) | Size symbol | Power supply input | Rated output of applicable motor | Built-in fan |
|---|---|---|---|---|---|
| MADN065BR☐ | 716C0004 | A | Single-phase/3-phase 200–240 V | Max 100 W | No |
| MADN085BR☐ | 716C0005 | | | Max 200 W | No |
| MBDN125BR☐ | 716C0006 | B | Single-phase/3-phase 200–240 V | Max 400 W | No |
| MCDN205BR☐ | 716C0050 | C | Single-phase/3-phase 200–240 V | Max 750 W | No |
| MDDN405BR☐ | 716C0009 | D | Single-phase/3-phase 200–240 V | Max 1000 W | Provided |

*1 This is the product code for our servo driver listed in the ESI file (Hexadecimal notation).

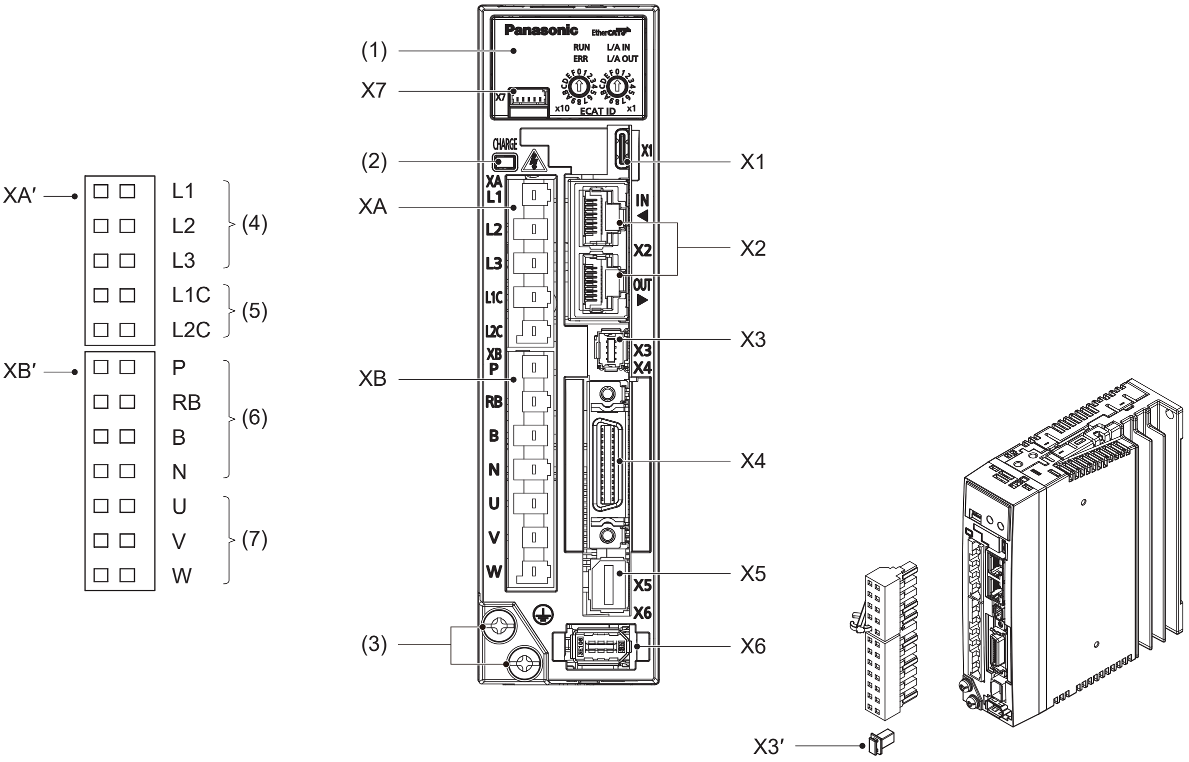
* For servo driver and motor combinations, see *“2.3 Driver and Motor Combinations”* . Some motors cannot be used even if they match the rated outputs shown in this table.

## 2.1.3 Part Names

The names of the driver parts are shown below by driver size.

For each size, the figure is for the multi-function type. The standard type does not have X3 (safety function connectors/safety bypass plug) or X5 (external scale connector).

### 2.1.3.1 Sizes A, B (100 V/200 V)



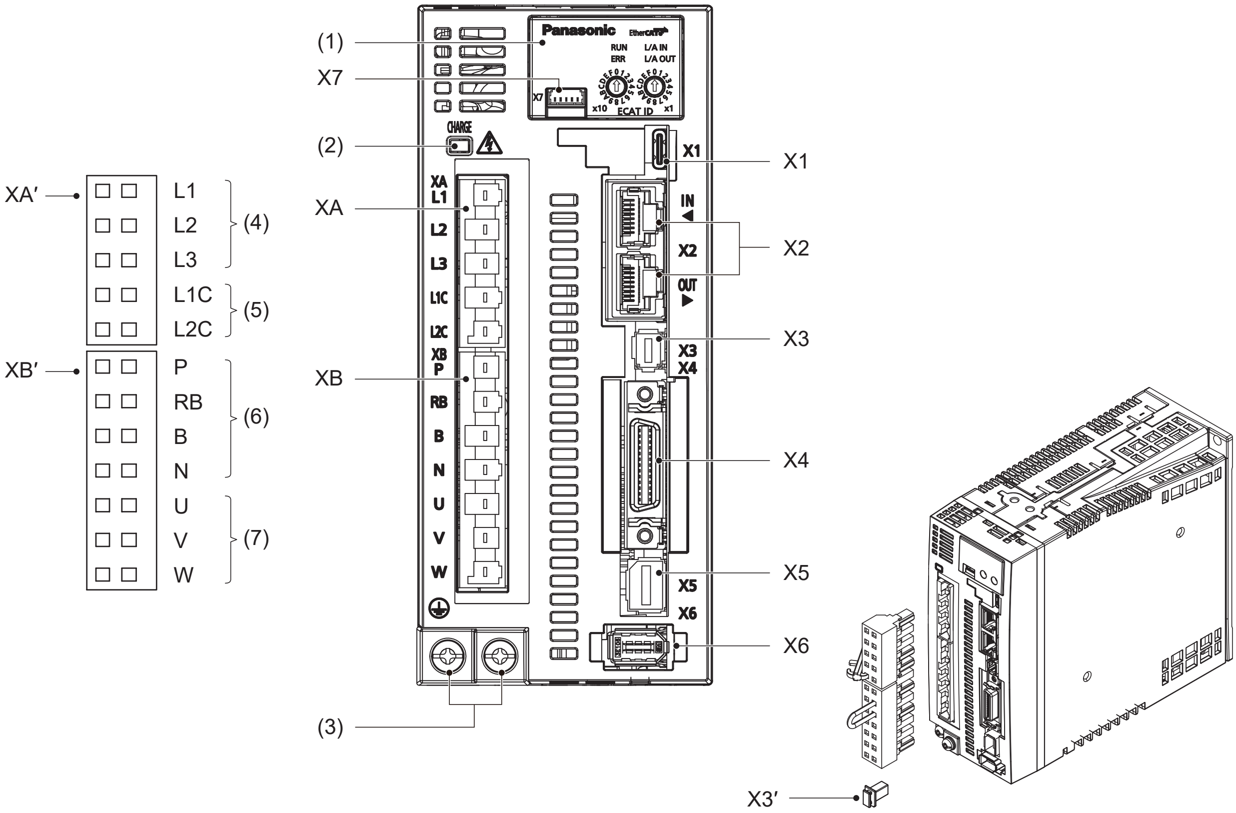
| | | | |
|---|---|---|---|
| X1 | USB connector<br>DX07S016JA3R1500 (JAE) or equivalent | X2 | EtherCAT connector<br>2301996-9 (TYCO) or equivalent |
| X3 | Safety function connector<br>2294417-1 (TYCO) or equivalent | X3' | Safety bypass plug<br>2371136-3 (TYCO) or equivalent |
| X4 | Parallel I/O connector<br>DF02R026NA2 (JAE) or equivalent | X5 | External scale connector<br>MUF-RS10SK-GKX-TB (LF) (JST) or equivalent |
| X6 | Encoder connector<br>2232261-3 (TYCO) or equivalent | X7 | Analog monitor connector<br>53398-4005 (Molex) or equivalent |
| XA | Power supply input connector<br>SC05B-JTSKM7.5SK-GSXKR (JST) or equivalent | XA' | Power supply input connector<br>05JFAT-SAXGSAK-KM7.5 (LA) (JST) or equivalent |
| XB | Motor output connector<br>SC07B-JTSKM7.5SK-GSXKR (JST) or equivalent | XB' | Motor output connector<br>07JFAT-SAXGSAK-KM7.5 (LA) (JST) or equivalent |
| (1) | Front panel | (2) | Charge lamp |
| (3) | Earth connection screw | (4) | Main power supply input terminal |
| (5) | Control power supply input terminal | (6) | Regenerative resistor connection terminal |
| (7) | Motor output terminal | | |

* Remove the safety bypass plug when wiring to X3.

**Notes**

- Connectors XA′ and XB′ are included with sizes A and B.

### 2.1.3.2 Sizes C, D (100 V/200 V)



| | | | |
|---|---|---|---|
| X1 | USB connector<br>DX07S016JA3R1500 (JAE) or equivalent | X2 | EtherCAT connector<br>2301996-9 (TYCO) or equivalent |
| X3 | Safety function connector<br>2294417-1 (TYCO) or equivalent | X3' | Safety bypass plug<br>2371136-3 (TYCO) or equivalent |
| X4 | Parallel I/O connector<br>DF02R026NA2 (JAE) or equivalent | X5 | External scale connector<br>MUF-RS10SK-GKX-TB (LF) (JST) or equivalent |
| X6 | Encoder connector<br>2232261-3 (TYCO) or equivalent | X7 | Analog monitor connector<br>53398-4005 (Molex) or equivalent |
| XA | Power supply input connector<br>SC05B-JTSKM7.5SK-GSXKR (JST) or equivalent | XA' | Power supply input connector<br>05JFAT-SAXGSAK-KM7.5 (LA) (JST) or equivalent |
| XB | Motor output connector<br>SC07B-JTSKM7.5SK-GSXKR (JST) or equivalent | XB' | Motor output connector<br>07JFAT-SAXGSAK-KM7.5 (LA) (JST) or equivalent |
| (1) | Front panel | (2) | Charge lamp |
| (3) | Earth connection screw | (4) | Main power supply input terminal |
| (5) | Control power supply input terminal | (6) | Regenerative resistor connection terminal |
| (7) | Motor output terminal | | |

* Remove the safety bypass plug when wiring to X3.

**Notes**

- Connector XA′ and XB′ are included with sizes C and D.

## 2.1.4 Specifications

### 2.1.4.1 Basic Specifications

The specifications of this product are as follows.

| Item | | | | Description |
|---|---|---|---|---|
| Input power supply | 100 V | Main circuit power supply | Sizes A to C | Single phase 100 to 120 V, -15% to +10%, 50/60 Hz |
| | | Control circuit power supply | Sizes A to C | Single phase 100 to 120 V, -15% to +10%, 50/60 Hz |
| | 200 V | Main circuit power supply | Sizes A to D | Single phase/3-phase 200 to 240 V, -15% to +10%, 50/60 Hz |
| | | Control circuit power supply | Sizes A to D | Single phase 200 to 240 V, -15% to +10%, 50/60 Hz |
| Ambient operating conditions | | Temperature | | Operating temperature 0 to 60°C (can be used at 55 to 60°C when derated (*5) ) (no freezing)<br>Storage temperature: -20°C to 65°C (Max. temperature guarantee: 80°C, cumulative 72 hours, no condensation (*1) ) |
| | | Humidity | | Operating/storage humidity: 20 to 85% RH or less (no condensation (*1) ) |
| | | Altitude | | 2000 m or lower (can be used at 1000 to 2000 m when derated (*5) ) |
| | | Vibration | | 5.88 $m/s^2$ or less, 10 to 60 Hz |
| | | Pollution degree | | Pollution degree 2 (IEC60664-1) |
| | | Mounting intervals | | 10 mm or more (can be used at 1 to 10 mm when derated (*5) ) |
| Overvoltage category | | | | III (IEC60364-4-44 and IEC60664-1) |
| Protective class | | | | I (IEC61140) |
| IP rating | | | | IP00 |
| Insulation voltage resistance | | | | Withstanding 1,500 V AC between primary and earth for 1 minute |
| Control method | | | | IGBT PWM method, sinusoidal drive |
| Encoder feedback | | | | 27-bit (134217728 resolution) absolute encoder, 7-wire serial |
| External scale feedback (*2) | | | | A/B-phase, home signal differential input type<br>Panasonic supported serial communication type (*4) |
| Control signal | | Input | | 8 general-purpose inputs<br>Select general-purpose input function based on parameters |
| | | Output | | 3 general-purpose outputs<br>Select general-purpose output function based on parameters |
| Analog signal | | Input | | 1 input (16-bit A/D input) (*3) |
| | | Output | | 2 outputs (analog monitor 1, analog monitor 2) |
| Pulse signal | | Output | | Switch with following with parameters and output line driver.<br>● Encoder pulse output (A/B-phase)<br>● Position comparison output (3 outputs) |
| Communication function | | EtherCAT | | Real-time operation command transmission, parameter setting, status monitoring, etc. |
| | | USB | | Connect to a computer for parameter setting or status monitoring, etc. |

| Item | | Description |
|---|---|---|
| Safety terminal (*2) | | Safe Torque Off (STO)<br>2 inputs (safety input 1, 2)<br>1 output (EDM output) |
| Front panel | | ● rotary switch<br>● 7-segment LED for display (2-digit) and 4 EtherCAT Indicator lights<br>● Analog monitor connector |
| Regeneration | | Sizes A and B: No built-in regenerative resistor (external only)<br>Sizes C and D: Built-in regenerative resistor (external also possible) |
| Dynamic brake | | Built-in |
| Control mode | Semi-closed control | ● Position Control: Profile position control (pp), cyclic position control (csp), homing position control (hm)<br>● Velocity Control: Profile velocity control (pv), cyclic velocity control (csv)<br>● Torque Control: Profile torque control (tq), cyclic torque control (cst) |
| | Full-closed control | ● Position Control: Profile position control (pp), cyclic position control (csp), homing position control (hm) |

*1 Please note that condensation tends to occur when the temperature drops.

*2 Cannot be used with the standard type.

*3 Only application specialized types can be used.

*4 For supported scale manufacturers and product numbers, see the “AC Servo Partner Products” catalog.

*5 See *“Derated Specifications”* .

## Derated Specifications

- When using servo drivers at an ambient temperature of 55 to 60°C, or at an altitude between 1000 and 2000 meters, use the load factor obtained by multiplying each of the load factors given in the below diagram.

  When derated, change Pr5.110 “Driver derating factor” from the initial value. For details on how to set parameters and check the load factor of the servo driver, see *“8.20 Driver Derating Function”* .

  For servo driver overload protection time characteristics, see *“2.1.4.2 Overload Protection Time Characteristics (Driver)”* .

  An example of Pr5.110 “Driver derating factor” configuration is shown below.

  - (Example 1) When used at an ambient temperature of 60°C and an altitude of 1000 m

    The figure shows that the load factor at an ambient temperature of 60°C is 85% and at an altitude of 1000 m the load factor is 100%. Multiplying each load factor yields 85% × 100% = 85%.

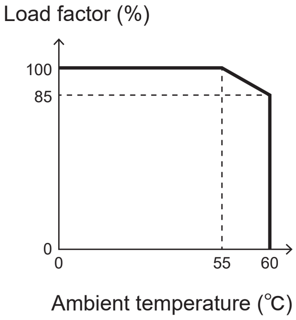
    For Pr5.110 “Driver derating factor” , set to "85".

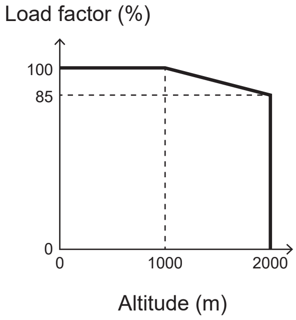
  - (Example 2) When used at an ambient temperature of 60°C and an altitude of 2000 m or less

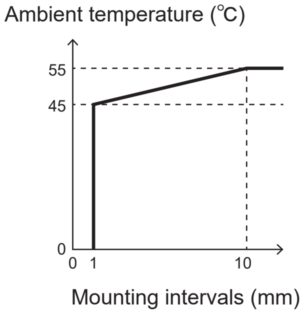
    The figure shows that the load factor at an ambient temperature of 60°C is 85% and at an altitude of 2000 m the load factor is 85%. Multiplying each load factor yields 85% × 85% = 72% (Round down to nearest decimal point).

    For Pr5.110 “Driver derating factor” , set to "72".

- If using servo drivers mounted at intervals of 1 to 10 mm, be sure to keep the below ambient temperatures in mind.


Load factor (%)
100
85
0
0
55
60
Ambient temperature (℃)


Load factor (%)
100
85
0
0
1000
2000
Altitude (m)


Ambient temperature (℃)
55
45
0
0
1
10
Mounting intervals (mm)

### 2.1.4.2 Overload Protection Time Characteristics (Driver)

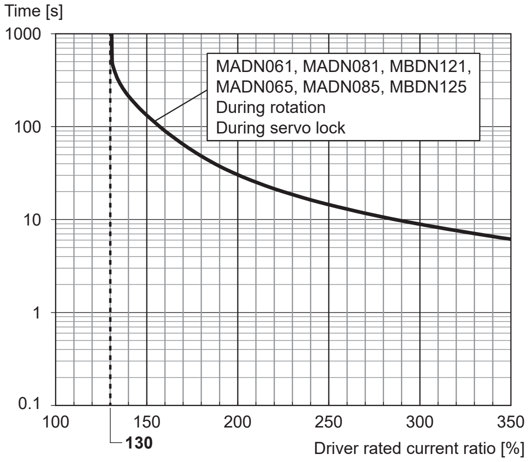
The driver overload warning function is activated when the overload protection time characteristic (driver) is reached.

Servo driver and servo motor overload warnings and protection functions (driver overload warning, motor overload warning, and motor overload protection) give priority to the lower between the overload protection time characteristic (driver) and overload protection time characteristic (motor). For details on overload protection time characteristics (motor), see *"2.2.5 Overload Protection Time Characteristics (Motor)"* .

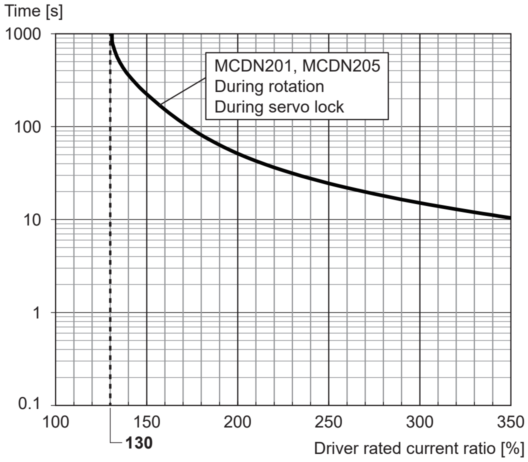
The figure below shows the overload protection time characteristics (driver) when Pr5.110 "Driver derating factor" is set to "100". See *"Derated Specifications"* in *"2.1.4.1 Basic Specifications"* and set Pr5.110 "Driver derating factor" according to the ambient operating conditions. Since the overload protection time characteristic of the servo driver changes depending on the set value of Pr5.110 "Driver derating factor" , tune the operating conditions so that the overload protection time characteristic (driver) is not reached.

See *"8.20 Driver Derating Function"* for more information on the driver derating function.

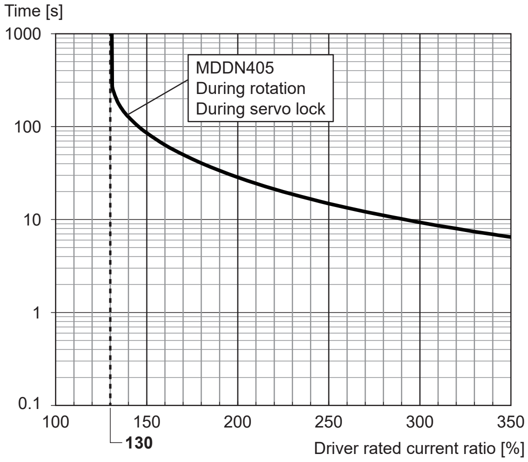
**Common to MADN and MBDN**



**MCDN201, MCDN205**



**MDDN405**



### 2.1.4.3 Supported Control Modes

The table below shows the control modes supported by the product and an overview of the control modes.

—: None

| Class | Control mode | | Abbre-viation | Description |
|---|---|---|---|---|
| — | NOP | NOP | NOP | A mode for sending temporary invalid data immediately after the network is established. |
| Semi-closed control | Profile position control mode | Profile position mode | pp | A position control mode in which the host device commands the target position, target speed, and acceleration/deceleration (parameters), and operates by generating position commands inside the servo driver. |
| | Cyclic position control mode | Cyclic synchronous position mode | csp | A position control mode in which the host device generates a position command, and operates by updating (sending) a command position in a command updating cycle. |
| | Homing position control mode | Homing mode | hm | This is a position control mode in which the host device designates settings such as the homing method, operating speed, etc., generates position commands inside the servo driver, and performs the homing operation. |
| | Profile velocity control mode | Profile velocity mode | pv | This is a velocity control mode in which the host device designates settings such as the target speed and acceleration/deceleration, and operates by generating position commands inside the servo driver. |
| | Cyclic velocity control mode | Cyclic synchronous velocity mode | csv | A velocity control mode in which the host device generates a speed command, and operates by updating (sending) the command speed in a communication cycle. |
| | Profile torque control mode | Torque profile mode | tq | This is a torque control mode in which the host device designates settings such as the target torque, and acceleration/deceleration, and operates by generating position commands inside the servo driver. |
| | Cyclic torque control mode | Cyclic synchronous torque mode | cst | A torque control mode in which the host device generates a torque command, and operates by updating (sending) the command torque in a communication cycle. |
| Full-closed control | Profile position control mode | Profile position mode | pp | A position control mode in which the host device commands the target position, target speed, and acceleration/deceleration (parameters), and operates by generating position commands inside the servo driver. |
| | Cyclic position control mode | Cyclic synchronous position mode | csp | A position control mode in which the host device generates a position command, and operates by updating (sending) a command position in a command updating cycle. |
| | Homing position control mode | Homing mode | hm | This is a position control mode in which the host device designates settings such as the homing method, operating speed, etc., generates position commands inside the servo driver, and performs the homing operation. |

### 2.1.4.4 Supported Functions (Function List and Overview)

The table below shows the functions supported by the product and an overview of those function.

The functions listed in gray in the table below are not supported in this software version.

| Class | Function name | Function overview | Reference |
|---|---|---|---|
| Input/ output | Positioning complete output (INP and INP2) | When in positioning complete state, this function outputs external output signal positioning complete output (INP) or positioning complete output 2 (INP2). | *"7.3.4"* |
| | Speed arrival output | A function that outputs speed arrival output (AT-SPEED), an external output signal, when the motor speed exceeds the set velocity. | *"7.4.4"* |
| | Velocity coincidence output | If the speed command and motor speed match, this function outputs a velocity coincidence output (V-COIN), which is an external signal. | *"7.4.5"* |
| Basic | Rotational direction setting | A function that sets motor rotational direction for the position command, speed command, and torque command. | *"7.2.1"* |
| | Command input processing | A function that sets the control mode according to the command input. | *"7.2.2"* |
| | Electronic gear function | This is a function that uses a value obtained by multiplying the position and speed control commands input from the host device by the electronic gear ratio set by the object as the position and speed commands for the position and speed control unit. | *"7.2.3"* |
| | Motor working range setup function | This function triggers an alarm and decelerates the motor to a stop if the motor position exceeds the set the movable motor range with respect to the position command input range. | *"7.2.4"* |
| | Two-degree-of-freedom control (position) | This is an extension function for each control mode that improves responsiveness by allowing command response and servo stiffness to be set independently. | *"7.2.5"* |
| | Two-degree-of-freedom control (speed) | | |
| | Two-degree-of-freedom control (full-closed) | | |
| | Regenerative resistor settings | A function that switches the regenerative resistance overload protection function setup. | *"7.2.6"* |
| | Absolute settings | A function that sets the method of use of the absolute encoder. | *"7.2.7"* |
| | Velocity limit function | A function that controls the velocity so that it does not exceed the velocity limit value set during torque control as a protection. | *"7.5.2"* |
| | External scale selection function | A function that selects the external scale type to be used and sets the reversal of external scale feedback counter. | *"7.2.8"* |
| | External scale dividing ratio settings | A function that sets the dividing ratio of encoder resolution and number of scale pulses per rotation. | *"7.6.4"* |
| | Hybrid Deviation Excess Setup | This function detects the difference between motor (encoder) position and load (external scale) position, and generates hybrid deviation excess error protection when the difference exceeds the allowable value. | *"7.6.5"* |
| | Full-closed control function (rotary scale) | Full-closed control function when using the rotary scale. | |
| | Batteryless absolute encoder | | |
| Adjustment | For details on adjustment functions, see Operating Instructions (Tuning). | | |
| Application | Torque limit switching function | This function changes the torque limit value according to the operation direction. | *"8.1"* |
| | Torque saturation protection function | This function triggers an alarm when torque saturation condition lasts for a set amount of time. | *"8.2"* |
| | Position comparison output function | A general-purpose output or position comparison output terminal outputs a pulse signal when the actual position passes the position set for the parameter. | *"8.3"* |

| Class | Function name | Function overview | Reference |
|---|---|---|---|
| Application | Single-turn absolute function | This function uses the absolute encoder as an absolute system only for single-turn absolute position. | *“8.4”* |
| | Continuous rotating absolute encoder function | This function sets any upper-limit value for absolute encoder multi-turn data. | *“8.5”* |
| | Pulse regeneration function | This function outputs the amount of movement of the actual position with the A/B-phase pulse. | *“8.6”* |
| | Displacement control function | This function directly inputs the output signal of the displacement sensor to the servo driver to achieve a fixed clearance for workpieces of varying height, completely within the driver. | *“8.7.1”* |
| | Virtual full-closed control function | This function enables continuous axis operation by virtually estimating the external scale position from the encoder position information. | |
| | External scale position information monitor function for semi-closed control | A function to monitor external scale position information with the EtherCAT object during semi-closed control. | *“8.8”* |
| | Deterioration diagnosis warning function | This is a function to check the changes in motor and connected equipment characteristics to output deterioration diagnosis warning. | *“8.9”* |
| | Touch probe function (*1) | This function latches the feedback position by selecting a latch trigger signal from the external inputs (EXT1 and EXT2) or the Z-phase. | *“6.6.8.1”* |
| | Retracting operation function | This function sets retracting operation initiation and operation contents when the main power supply is OFF or the retracting operation signal is input. | *“8.10”* |
| | Deceleration to stop function | This function sets the motor deceleration stop method in the event of main power interruption or alarm. | *“8.11”* |
| | Deceleration to stop function for during over-travel inhibit input (POT, NOT) | This function sets the mid-deceleration and post-stop operations after over-travel inhibit input (POT, NOT) is input. | *“8.12”* |
| | Deceleration to Stop Function for Servo Off | This function sets the mid-deceleration stopping method and post-stop operations when the servo is off. | *“8.13”* |
| | Deceleration to stop function for when main power supply is off | This function sets the stopping method during deceleration and post-stop operations after the main power supply is turned OFF. | *“8.14”* |
| | Deceleration to stop function for when alarm is triggered | This function sets the mid-deceleration stopping method and post-stop operations when an alarm is triggered. | *“8.15”* |
| | Emergency stop function for when alarm is triggered | This function sets the stopping operations when an emergency stop alarm is triggered. | *“8.16”* |
| | Fall prevention function for when alarm is triggered | This function prevents falls when an alarm triggers by setting the alarm deceleration to stop function to emergency stop. | *“8.17”* |
| | Fall prevention function for servo-on | This function eliminates the delay in torque command rise at the servo-on command input timing and prevents the equipment from falling. | *“8.18”* |
| | Slow stop function | This function stops the motor smoothly with servo-on when the main power is turned off or an alarm occurs with the emergency stop setting. | *“8.19”* |
| | Driver derating function | Derating is applied to the servo driver's overload protection time characteristic according to the derating factor set by the parameter. | *“8.20”* |
| | EoE (Ethernet over EtherCAT) | This function allows Ethernet frames to be transmitted (EoE communication) between the main device and a sub device in the EtherCAT segment by encapsulating the Ethernet packet in a EtherCAT Mailbox packet. | *“4.2.9”* |
| Safety | Safety function | This function turns off the motor output torque by forcibly turning off the driving signal of the power transistor inside the servo driver from the safety input signal by means of an electric circuit (hardware), thereby cutting off the motor current. | *“9.1”* |
| Protection | Protection functions | These functions ensure safety by stopping the motor when errors are detected in the equipment. | *“10.2”* |

| Class | Function name | Function overview | Reference |
|---|---|---|---|
| Protection | Warning functions | These functions generate a warning before a protection function is triggered to check in advance for a condition, such as an overload. | *“10.3”* |
| | Timestamp function | This function adds the time when the alarm occurred to the alarm supplementary information and adds the measurement time to the waveform data measured by the waveform measurement function with Set-up Support Software (PANATERM ver.7) . | *“10.4”* |

*1 External scale z-phase latch function for semi-closed control is not currently compatible.

### 2.1.4.5 Supported Functions (By Driver Type)

The table below shows the functions supported by this product by driver type.

The functions listed in gray in the table below are not supported in this software version.

○: Supported ×: Not supported

| Class | Function | Driver Type | | |
|---|---|---|---|---|
| | | A7BE<br>Standard type | A7BF<br>Multi-function type | A7BR<br>Application specialized type |
| Control mode | Semi-closed control | | | |
| | Profile position control mode (pp) | ○ | ○ | ○ |
| | Cyclic position control mode (csp) | ○ | ○ | ○ |
| | Homing position control mode (hm) | ○ | ○ | ○ |
| | Profile velocity control mode (pv) | ○ | ○ | ○ |
| | Cyclic velocity control mode (csv) | ○ | ○ | ○ |
| | Profile torque control mode (tq) | ○ | ○ | ○ |
| | Cyclic torque control mode (cst) | ○ | ○ | ○ |
| | Full-closed control | | | |
| | Profile position control mode (pp) | × | ○ | ○ |
| | Cyclic position control mode (csp) | × | ○ | ○ |
| | Homing position control mode (hm) | × | ○ | ○ |
| | Full-closed control (rotary scale) | × | × | × |
| Input/ output | Analog input | × | × | ○ |
| | Analog output (analog monitor 1, analog monitor 2) | ○ | ○ | ○ |
| | External scale division/multiplication settings | ○ | ○ | ○ |
| | Positioning complete output (INP/INP2) | ○ | ○ | ○ |
| | Speed arrival output | ○ | ○ | ○ |
| | Velocity coincidence output | ○ | ○ | ○ |
| Basic | Rotational direction setting | ○ | ○ | ○ |
| | Command input processing | ○ | ○ | ○ |
| | Electronic gear function | ○ | ○ | ○ |
| | Motor working range setup function | ○ | ○ | ○ |
| | Two-degree-of-freedom control (position) | ○ | ○ | ○ |
| | Two-degree-of-freedom control (speed) | ○ | ○ | ○ |
| | Two-degree-of-freedom control (full-closed) | × | ○ | ○ |
| | Regenerative resistor settings | ○ | ○ | ○ |
| | Absolute settings | ○ | ○ | ○ |
| | Velocity limit function | ○ | ○ | ○ |
| | External scale selection function | × | ○ | ○ |
| | External scale dividing ratio settings | × | ○ | ○ |
| | Hybrid Deviation Excess Setup | × | ○ | ○ |
| | Full-closed control function (rotary scale) | × | × | × |
| | Batteryless absolute encoder | × | × | × |
| Adjustment | For details on adjustment functions, see Operating Instructions (Tuning). | | | |

| Class | Function | Driver Type | | |
|---|---|---|---|---|
| | | A7BE<br>Standard type | A7BF<br>Multi-function type | A7BR<br>Application specialized type |
| Application | Torque limit switching function | ○ | ○ | ○ |
| | Torque saturation protection function | ○ | ○ | ○ |
| | Position comparison output function | ○ | ○ | ○ |
| | Single-turn absolute function | ○ | ○ | ○ |
| | Continuous rotating absolute encoder function | ○ | ○ | ○ |
| | Pulse regeneration function | ○ | ○ | ○ |
| | Displacement control function | × | × | ○ |
| | Virtual full-closed control function | × | × | × |
| | External scale position information monitor function for semi-closed control | × | ○ | ○ |
| | Deterioration diagnosis warning function | × | × | × |
| | Touch probe function (*1) | ○ | ○ | ○ |
| | Retracting operation function | × | × | × |
| | Deceleration to stop function | ○ | ○ | ○ |
| | Deceleration to stop function for during over-travel inhibit input (POT, NOT) | ○ | ○ | ○ |
| | Deceleration to Stop Function for Servo Off | ○ | ○ | ○ |
| | Deceleration to stop function for when main power supply is off | ○ | ○ | ○ |
| | Deceleration to stop function for when alarm is triggered | ○ | ○ | ○ |
| | Emergency stop function for when alarm is triggered | ○ | ○ | ○ |
| | Fall prevention function for when alarm is triggered | ○ | ○ | ○ |
| | Fall prevention function for servo-on | ○ | ○ | ○ |
| | Slow stop function | ○ | ○ | ○ |
| | Driver derating function | ○ | ○ | ○ |
| | EoE (Ethernet over EtherCAT) | × | × | × |
| Safety | Safety function | × | ○ | ○ |
| Protection | Protection functions | ○ | ○ | ○ |
| | Warning functions | ○ | ○ | ○ |
| | Timestamp function | ○ | ○ | ○ |

*1 External scale z-phase latch function for semi-closed control is not currently compatible.

### 2.1.4.6 Supported Functions (By Control Mode)

The table below shows the functions supported by this product by control mode.

The functions listed in gray in the table below are not supported in this software version.

○: Supported ×: Not supported

| Class | Function | Description | | | |
|---|---|---|---|---|---|
| | | Position control | Velocity control | Torque control | Full-closed control |
| Input/ output | Control input | Positive direction drive inhibit, negative direction drive inhibit, latch signal, near home position, etc. | Positive direction drive inhibit, negative direction drive inhibit, latch signal, etc. | Positive direction drive inhibit, negative direction drive inhibit, latch signal, etc. | Positive direction drive inhibit, negative direction drive inhibit, latch signal, near home position, etc. |
| | Control output | Positioning completion, etc. | Velocity arrival, etc. | Velocity arrival, etc. | Positioning completion, etc. |
| | Command input (EtherCAT command type) | Position command | Speed command | Torque command | Position command |
| | Smoothing filter | ○ | × | × | ○ |
| | Analog input | ○ | × | × | ○ |
| | Analog output (analog monitor 1, analog monitor 2) | ○ | ○ | ○ | ○ |
| | External scale division/multiplication settings | × | × | × | ○ |
| | Positioning complete output (INP/INP2) | ○ | × | × | ○ |
| | Speed arrival output | × | ○ | ○ | × |
| | Velocity coincidence output | × | ○ | ○ | × |
| Basic | Rotational direction setting | ○ | ○ | ○ | ○ |
| | Command input processing | ○ | ○ | ○ | ○ |
| | Electronic gear function | ○ | ○ | ○ | ○ |
| | Motor working range setup function | ○ | × | × | ○ |
| | Two-degree-of-freedom control mode (position) | ○ | × | × | × |
| | Two-degree-of-freedom control mode (speed) | × | ○ | × | × |
| | Two-degree-of-freedom control mode (full-closed) | × | × | × | ○ |
| | Regenerative resistor settings | ○ | ○ | ○ | ○ |
| | Absolute settings | ○ | ○ | ○ | × |
| | Velocity limit function | × | × | ○ | × |
| | External scale selection function | ○ | ○ | ○ | ○ |

| Class | Function | Description | | | |
|---|---|---|---|---|---|
| | | Position control | Velocity control | Torque control | Full-closed control |
| Basic | External scale dividing ratio settings | × | × | × | ○ |
| | Hybrid Deviation Excess Setup | × | × | × | ○ |
| | Full-closed control function (rotary scale) | × | × | × | × |
| | Batteryless absolute encoder | × | × | × | × |
| Adjustment | For details on adjustment functions, see Operating Instructions (Tuning). | | | | |
| Application | Torque limit switching function | ○ | ○ | ○ | ○ |
| | Torque saturation protection function | ○ | ○ | × | ○ |
| | Position comparison output function | ○ | ○ | ○ | ○ |
| | Single-turn absolute function | ○ | ○ | ○ | × |
| | Continuous rotating absolute encoder function | ○ | ○ | ○ | × |
| | Pulse regeneration function | ○ | ○ | ○ | ○ |
| | Displacement control function | ○ | × | × | ○ |
| | Virtual full-closed control function | × | × | × | × |
| | External scale position information monitor function for semi-closed control | ○ | ○ | ○ | × |
| | Deterioration diagnosis warning function | × | × | × | × |
| | Touch probe function (*1) | ○ | ○ | ○ | ○ |
| | Retracting operation function | × | × | × | × |
| | Deceleration to stop function | ○ | ○ | ○ | ○ |
| | Deceleration to stop function for during over-travel inhibit input (POT, NOT) | ○ | ○ | ○ | ○ |
| | Deceleration to Stop Function for Servo Off | ○ | ○ | ○ | ○ |
| | Deceleration to stop function for when main power supply is off | ○ | ○ | ○ | ○ |
| | Deceleration to stop function for when alarm is triggered | ○ | ○ | ○ | ○ |

| Class | Function | Description | | | |
|---|---|---|---|---|---|
| | | Position control | Velocity control | Torque control | Full-closed control |
| Application | Emergency stop function for when alarm is triggered | ○ | ○ | ○ | ○ |
| | Fall prevention function for when alarm is triggered | ○ | ○ | ○ | ○ |
| | Fall prevention function for servo-on | ○ | ○ | × | ○ |
| | Slow stop function | ○ | ○ | ○ | × |
| | Driver derating function | ○ | ○ | ○ | ○ |
| | EoE (Ethernet over EtherCAT) | × | × | × | × |
| Safety | Safety function | ○ | ○ | ○ | ○ |
| Protection | Protection functions | ○ | ○ | ○ | ○ |
| | Warning functions | ○ | ○ | ○ | ○ |
| | Timestamp function | ○ | ○ | ○ | ○ |

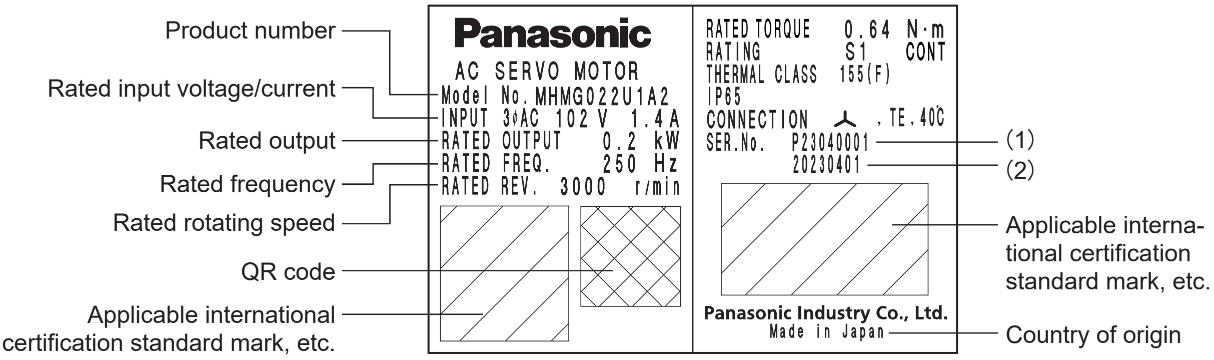
*1 External scale z-phase latch function for semi-closed control is not currently compatible.

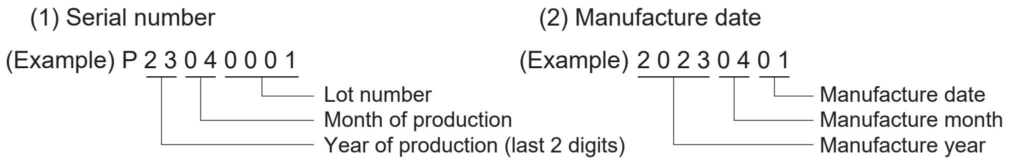
## 2.2 Motor

### 2.2.1 Checking the Model

**Nameplate Example**

The details shown on nameplates are as shown below.





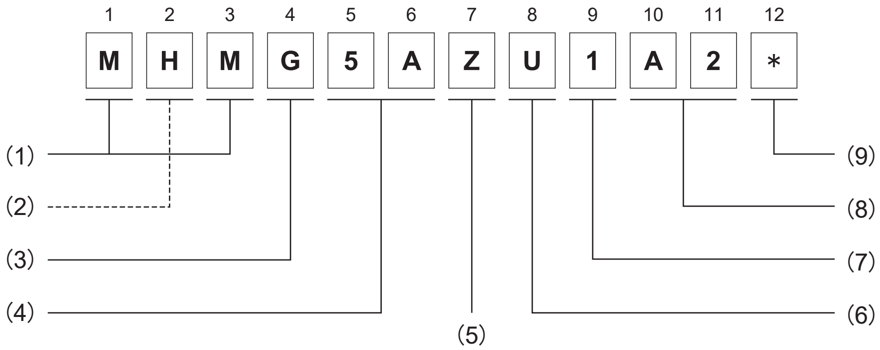
The range of the lot number in serial number is 1 to 33999, but the nameplate has 4 digits in the following format. In the four digits, the alphabet characters "I" (eye) and "O" (o) are not used.

| Value of serial number | Notation on the name-plate |
|---|---|
| 1 to 9999 | 0001 to 9999 |
| 10000 to 10999 | A000 to A999 |
| 11000 to 11999 | B000 to B999 |
| … | … |
| 17000 to 17999 | H000 to H999 |
| 18000 to 18999 | J000 to J999 |
| … | … |
| 22000 to 22999 | N000 to N999 |
| 23000 to 23999 | P000 to P999 |
| … | … |
| 33000 to 33999 | Z000 to Z999 |

## How to Read Product Numbers

Product numbers, symbols, and their meanings are as shown below.

### Sample description



| No. | Item | Symbol | Specifications | Remarks |
|---|---|---|---|---|
| (1) | Product | M☐M | Motor | ☐ = type symbol/mark |
| (2) | Type | H | High inertia | — |
| (3) | Family | G | A7 Family | — |
| (4) | Motor rated output | 5 A | 50 W | — |
| | | 01 | 100 W | |
| | | 02 | 200 W | |
| | | 04 | 400 W | |
| | | 08 | 750 W | |
| | | 09 | 1000 W | |
| (5) | Voltage specification | 1 | 100 V | — |
| | | 2 | 200 V | |
| | | Z | 100/200 V common (50 W only) | |
| (6) | Rotary encoder specifications | U | Absolute | Pulse no.: 27 bits<br>Resolution: 134217728<br>Lead wire: 7-cores |
| (7) | Design order | 1 | Standard | — |
| (8) | Motor structure | (*1) | (*1) | (*1) See “Motor Structure”. |
| (9) | Special specifications | * | — | Alphanumerics |

*1 Motor structure

Motor structure symbols, and their meanings are as shown below.

●: Supported Blank: Not supported

| Symbol | Shaft specification | | | Holding brake | | Oil seal | | Motor I/F |
|---|---|---|---|---|---|---|---|---|
| | Straight | D-cut | With key and tap | No | Yes | No | Yes | Lead wire |
| A2 | ● | | | ● | | ● | | ● |
| B2 | ● | | | | ● | ● | | ● |
| C2 | ● | | | ● | | | ● | ● |
| D2 | ● | | | | ● | | ● | ● |
| N2 | | ● | | ● | | ● | | ● |
| P2 | | ● | | | ● | ● | | ● |
| Q2 | | ● | | ● | | | ● | ● |

| Symbol | Shaft specification | | | Holding brake | | Oil seal | | Motor I/F |
|---|---|---|---|---|---|---|---|---|
| | Straight | D-cut | With key and tap | No | Yes | No | Yes | Lead wire |
| R2 | | ● | | | ● | | ● | ● |
| S2 | | | ● | ● | | ● | | ● |
| T2 | | | ● | | ● | ● | | ● |
| U2 | | | ● | ● | | | ● | ● |
| V2 | | | ● | | ● | | ● | ● |

## 2.2.2 Model Product Numbers

| Applicable Models | Motor Rating | Other Specifications |
|---|---|---|
| MHMG5AZU1☐2 | 50 W, 100 V/200 V shared | Shaft specification: Straight/D-cut/With key and tap<br>Oil seal: Without/With<br>Holding brake: Without/With |
| MHMG011U1☐2 | 100 W, 100 V | |
| MHMG012U1☐2 | 100 W, 200 V | |
| MHMG021U1☐2 | 200 W, 100 V | |
| MHMG022U1☐2 | 200 W, 200 V | |
| MHMG041U1☐2 | 400 W, 100 V | |
| MHMG042U1☐2 | 400 W, 200 V | |
| MHMG082U1☐2 | 750 W, 200 V | |
| MHMG092U1☐2 | 1000 W, 200 V | |

* See *“How to Read Product Numbers”* *“Motor structure”* in *“2.2.1 Checking the Model”* for what the ☐ symbols in the applicable model names represent.

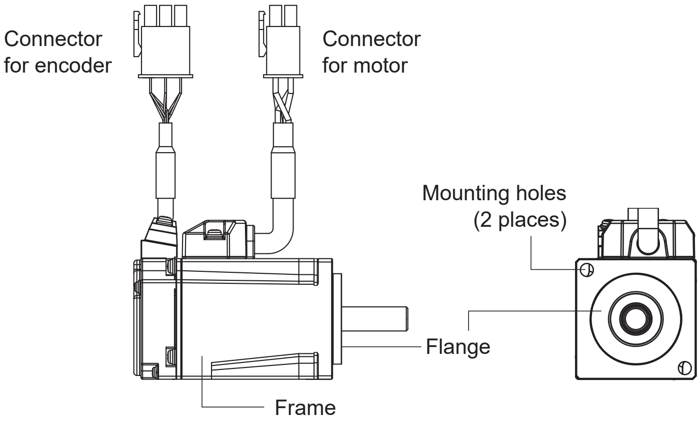
## 2.2.3 Part Names

The names and descriptions of the motor parts by model are as shown below.

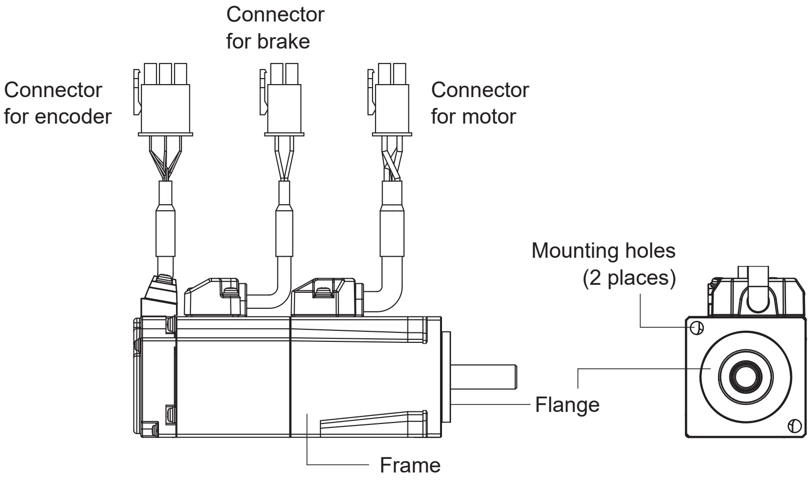
For details by motor model, see *“12.2.2 Motor (Absolute Encoder Specification)”* .

### ■ MHMG 50 W and 100 W (□40)

[Without brake]

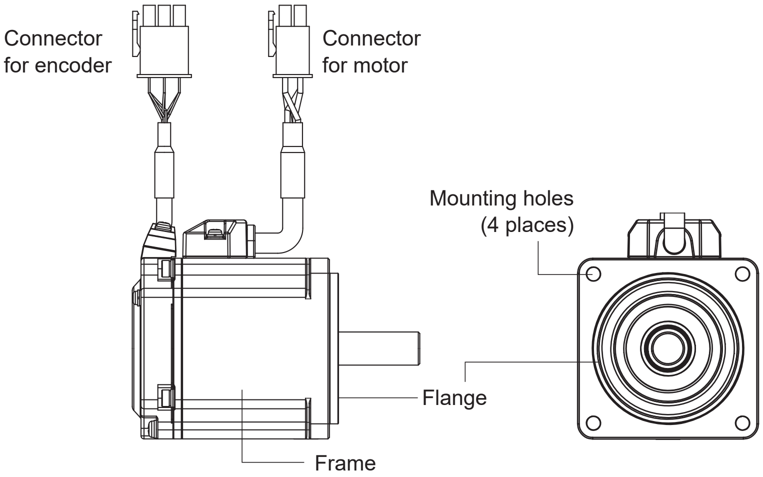


[With brake]

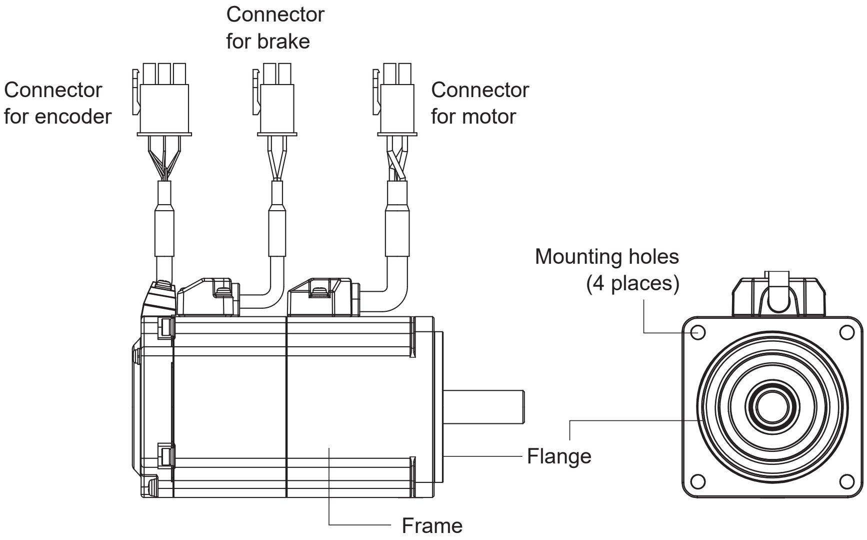


## ■ MHMG 200 W, 400 W (□60)

[Without brake]

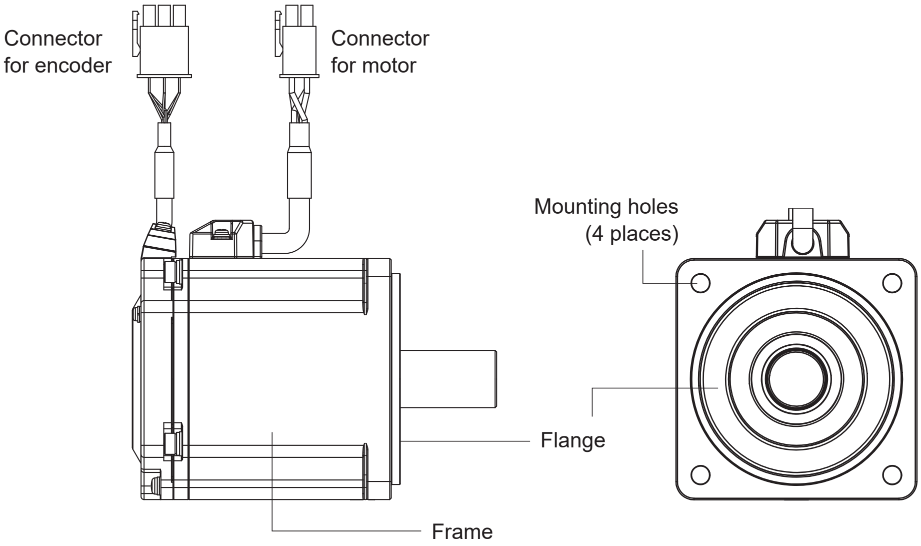


[With brake]

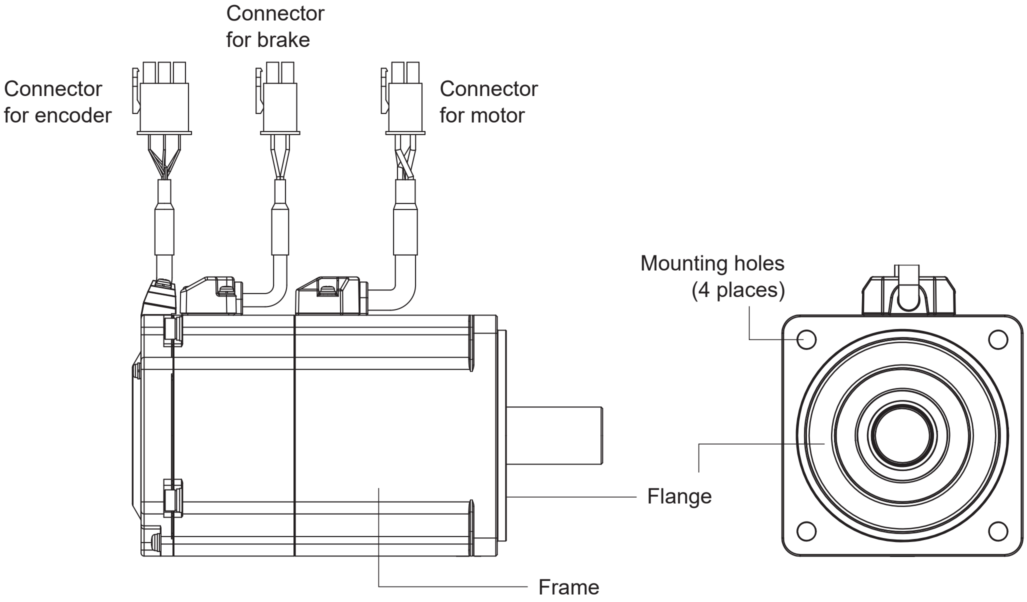


## ■ MHMG 750 W and 1000 W (□80)

[Without brake]



[With brake]



### 2.2.4 Specifications

Motor specifications are shown by motor.

The □△ symbols in the AC servo motor model names indicate differences in motor structure.

**— Precautions —**

- The motor characteristics (S-T characteristic) may vary depending on whether oil seals or brakes are used.

  Motor characteristics are subject to change, so be sure to check the motor characteristics of your motor when designing your system.
- The motor characteristics are shown after adjustment for combination with our servo driver (Representative values at 20°C).
- Rated torque values represent continuous allowable torque tolerance under our measurement conditions.
- If a faster response is desired, use a lower load moment of inertia ratio.

### 2.2.4.1 MHMG5AZU1□△ (50 W 100 V/200 V shared)

## ■ Specifications

| Motor product number | Unit | MHMG5AZU1□△ | |
|---|---|---|---|
| Brake | | No | Yes |
| Oil seal | | Without/With | |
| Rated output | W | 50 | |
| Compatible driver | | MADN061□□ | |
| | | MADN065□□ | |
| Driver power supply and voltage specifications | VAC | 100/200 | |
| Rated torque | N·m | 0.16 | |
| Instantaneous maximum torque | N·m | 0.56 | |
| Rated current | A(rms) | (1.1) | |
| Instantaneous maximum current | A(0-p) | (5.5) | |
| Rated rotational velocity | r/min | 3000 | |
| Maximum rotational velocity | r/min | 7150 | |
| Rotor inertial moment | $\times 10^{-4}$kg·m$^2$ | 0.0366 | 0.0401 |

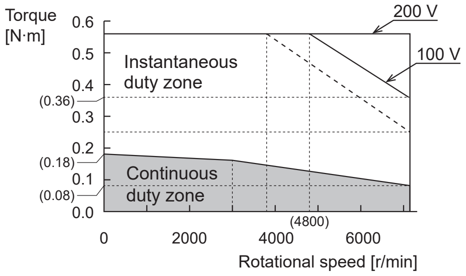
**— Precautions —**

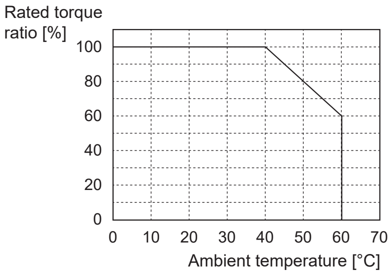
- Use in a location where the temperature at the center of the motor frame is below 75°C (When the ambient temperature is 40°C at an altitude of 1000 m or less).

## ■ S-T characteristics (representative values)

Servo driver power supply voltage: For 100 V/200 V AC (dotted line indicates 10% drop in power supply voltage 100 V)

- Without oil seal

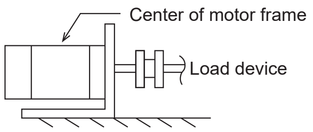




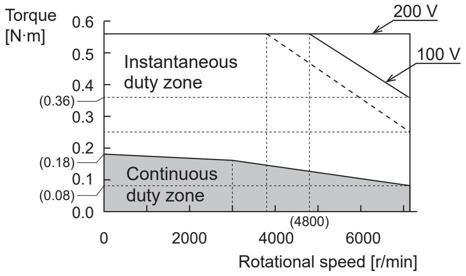
Measurement conditions

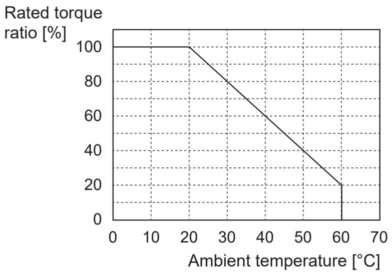
Flange size: 200 × 200 × t6

Material: Aluminum



- With oil seal

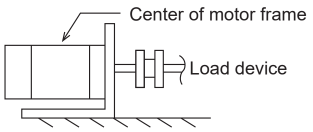




Measurement conditions

Flange size: 200 × 200 × t6

Material: Aluminum



### 2.2.4.2 MHMG011U1□△ (100 W 100 V), MHMG012U1□△ (100 W 200 V)

#### ■ Specifications

| Motor product number | Unit | MHMG011U1□△ | | MHMG012U1□△ | |
|---|---|---|---|---|---|
| Brake | | No | Yes | No | Yes |
| Oil seal | | Without/With | | Without/With | |
| Rated output | W | 100 | | 100 | |
| Compatible driver | | MADN081□□ | | MADN065□□ | |
| Driver power supply and voltage specifications | VAC | 100 | | 200 | |
| Rated torque | N·m | 0.32 | | 0.32 | |
| Instantaneous maximum torque | N·m | 1.11 | | 1.11 | |
| Rated current | A(rms) | (1.6) | | (1.1) | |
| Instantaneous maximum current | A(0-p) | (8.0) | | (5.5) | |
| Rated rotational velocity | r/min | 3000 | | 3000 | |
| Maximum rotational velocity | r/min | 7150 | | 7150 | |
| Rotor inertia | $\times 10^{-4}$kg·m$^2$ | 0.0648 | 0.0674 | 0.0648 | 0.0674 |

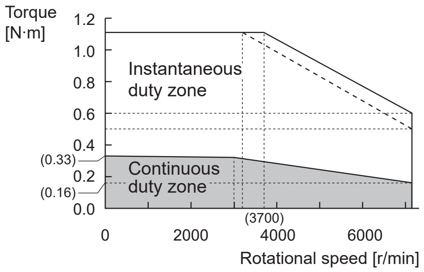
**— Precautions —**

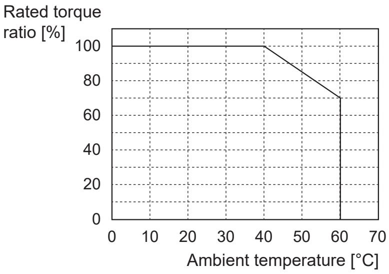
- Use in a location where the temperature at the center of the motor frame is below 85°C (When the ambient temperature is 40°C at an altitude of 1000 m or less).

#### ■ S-T characteristics (representative values)

Servo driver power supply voltage: For 100 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG011U1□ △ Without oil seal

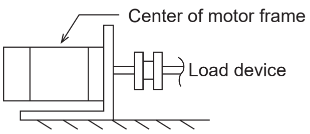




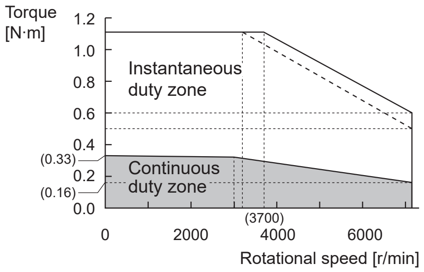
Measurement conditions

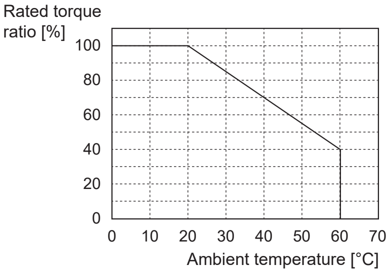
Flange size: 200 × 200 × t6

Material: Aluminum



- MHMG011U1□△ With oil seal

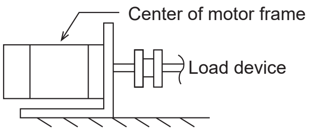




Measurement conditions

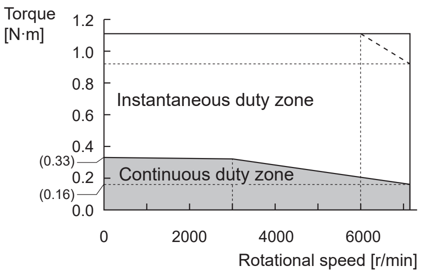
Flange size: 200 × 200 × t6

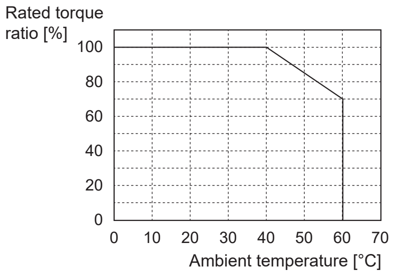
Material: Aluminum



Servo driver power supply voltage: For 200 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG012U1□ △ Without oil seal

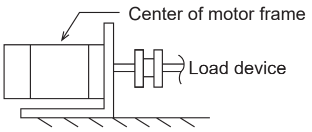




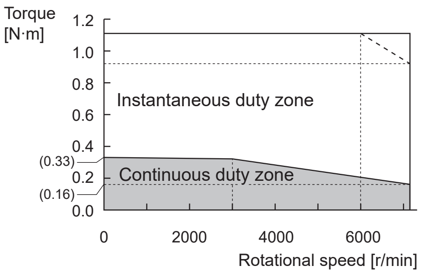
Measurement conditions

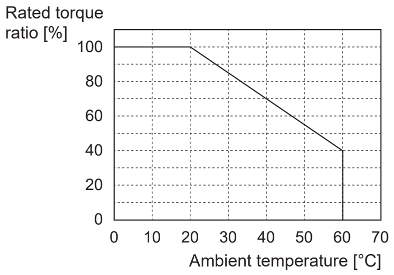
Flange size: 200 × 200 × t6

Material: Aluminum



- MHMG012U1□△ With oil seal

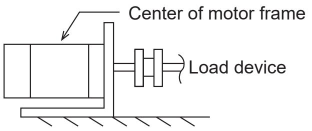




Measurement conditions

Flange size: 200 × 200 × t6

Material: Aluminum



### 2.2.4.3 MHMG021U1□△ (200 W 100 V), MHMG022U1□△ (200 W 200 V)

#### ■ Specifications

| Motor product number | Unit | MHMG021U1□△ | | MHMG022U1□△ | |
|---|---|---|---|---|---|
| Brake | | No | Yes | No | Yes |
| Oil seal | | Without/With | | Without/With | |
| Rated output | W | 200 | | 200 | |
| Compatible driver | | MBDN121□□ | | MADN085□□ | |
| Driver power supply and voltage specifications | VAC | 100 | | 200 | |
| Rated torque | N·m | 0.64 | | 0.64 | |
| Instantaneous maximum torque | N·m | 2.23 | | 2.23 | |
| Rated current | A(rms) | (2.2) | | (1.4) | |
| Instantaneous maximum current | A(0-p) | (11) | | (6.9) | |
| Rated rotational velocity | r/min | 3000 | | 3000 | |
| Maximum rotational velocity | r/min | 6700 | | 7150 | |
| Rotor inertial moment | $\times 10^{-4}$kg·m$^2$ | 0.254 | 0.271 | 0.254 | 0.271 |

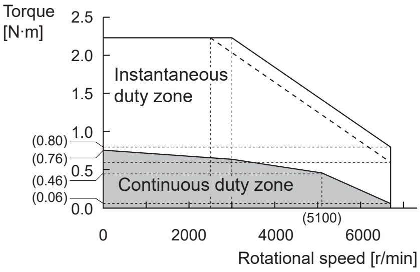
**— Precautions —**

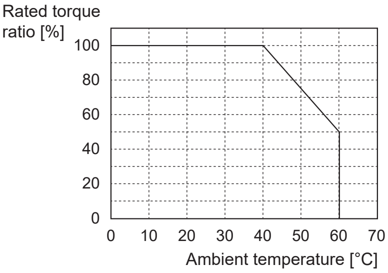
- Use in a location where the temperature at the center of the motor frame is below 75°C (When the ambient temperature is 40°C at an altitude of 1000 m or less).

#### ■ S-T characteristics (representative values)

Servo driver power supply voltage: For 100 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG021U1□ △ Without oil seal

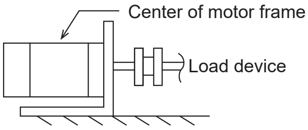




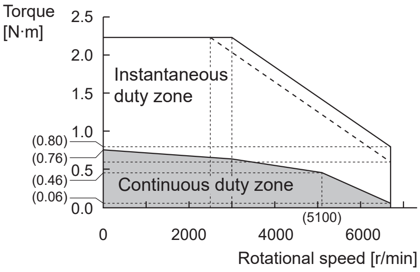
Measurement conditions

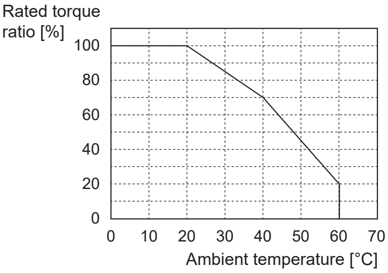
Flange size: 130 × 120 × t12

Material: Aluminum



- MHMG021U1□△ With oil seal

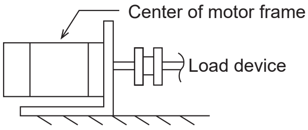




Measurement conditions

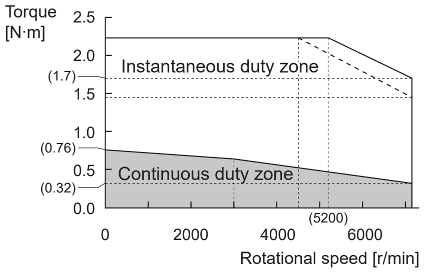
Flange size: 130 × 120 × t12

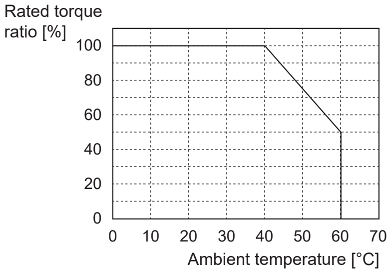
Material: Aluminum



Servo driver power supply voltage: For 200 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG022U1□ △ Without oil seal

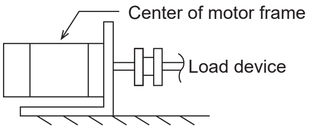




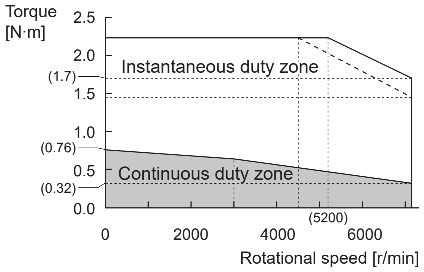
Measurement conditions

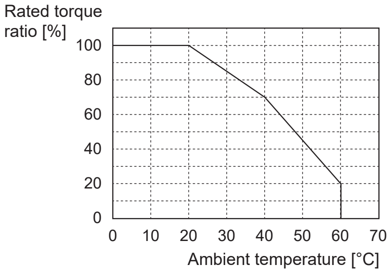
Flange size: 130 × 120 × t12

Material: Aluminum



- MHMG022U1□△ With oil seal

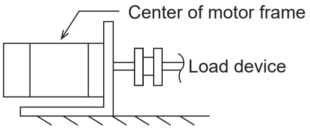




Measurement conditions

Flange size: 130 × 120 × t12

Material: Aluminum



### 2.2.4.4 MHMG041U1□△ (400 W 100 V), MHMG042U1□△ (400 W 200 V)

#### ■ Specifications

| Motor product number | Unit | MHMG041U1□△ | | MHMG042U1□△ | |
|---|---|---|---|---|---|
| Brake | | No | Yes | No | Yes |
| Oil seal | | Without/With | | Without/With | |
| Rated output | W | 400 | | 400 | |
| Compatible driver | | MCDN201□□ | | MBDN125□□ | |
| Driver power supply and voltage specifications | VAC | 100 | | 200 | |
| Rated torque | N·m | 1.27 | | 1.27 | |
| Instantaneous maximum torque | N·m | 4.46 | | 4.46 | |
| Rated current | A(rms) | (4.1) | | (2.2) | |
| Instantaneous maximum current | A(0-p) | (20) | | (11) | |
| Rated rotational velocity | r/min | 3000 | | 3000 | |
| Maximum rotational velocity | r/min | 6700 | | 6700 | |
| Rotor inertial moment | $\times10^{-4}$kg·m$^2$ | 0.462 | 0.479 | 0.462 | 0.479 |

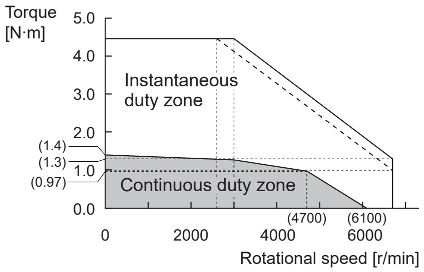
**— Precautions —**

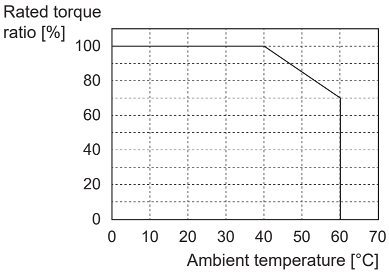
- Use in a location where the temperature at the center of the motor frame is below 85°C (When the ambient temperature is 40°C at an altitude of 1000 m or less).

#### ■ S-T characteristics (representative values)

Servo driver power supply voltage: For 100 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG041U1□ △ Without oil seal

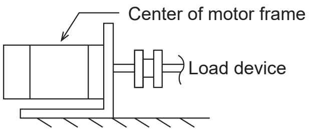




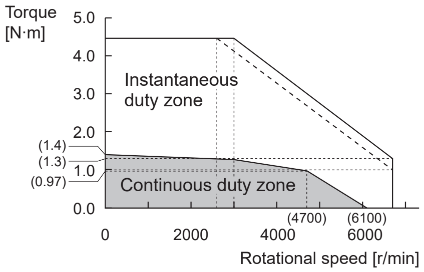
Measurement conditions

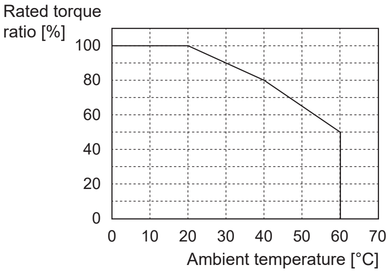
Flange size: 130 × 120 × t12

Material: Aluminum



- MHMG041U1□△ With oil seal

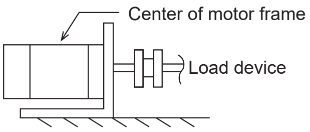




Measurement conditions

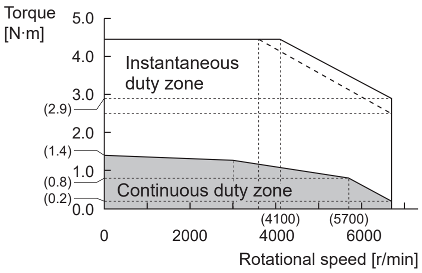
Flange size: 130 × 120 × t12

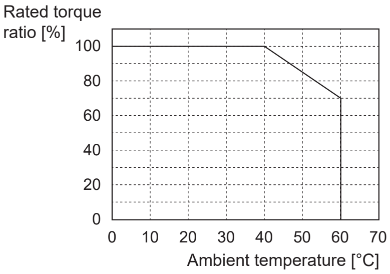
Material: Aluminum



Servo driver power supply voltage: For 200 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG042U1□ △ Without oil seal

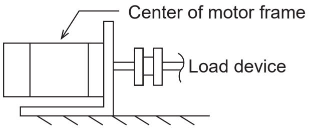




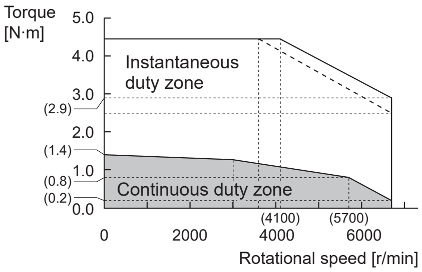
Measurement conditions

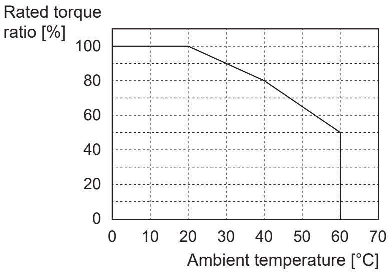
Flange size: 130 × 120 × t12

Material: Aluminum



- MHMG042U1□△ With oil seal

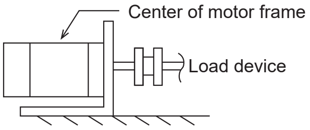




Measurement conditions

Flange size: 130 × 120 × t12

Material: Aluminum



### 2.2.4.5 MHMG082U1□△ (750 W 200 V), MHMG092U1□△ (1000 W 200 V)

#### ■ Specifications

| Motor product number | Unit | MHMG082U1□△ | | MHMG092U1□△ | |
|---|---|---|---|---|---|
| Brake | | No | Yes | No | Yes |
| Oil seal | | Without/With | | Without/With | |
| Rated output | W | 750 | | 1000 | |
| Compatible driver | | MCDN205□□ | | MDDN405□□ | |
| Driver power supply and voltage specifications | VAC | 200 | | 200 | |
| Rated torque | N·m | 2.39 | | 3.18 | |
| Instantaneous maximum torque | N·m | 8.36 | | 11.1 | |
| Rated current | A(rms) | (3.8) | | (5.7) | |
| Instantaneous maximum current | A(0-p) | (20) | | (30) | |
| Rated rotational velocity | r/min | 3000 | | 3000 | |
| Maximum rotational velocity | r/min | 6000 | | 6700 | |
| Rotor inertial moment | $\times 10^{-4}$kg·m$^2$ | 1.30 | 1.38 | 1.72 | 1.80 |

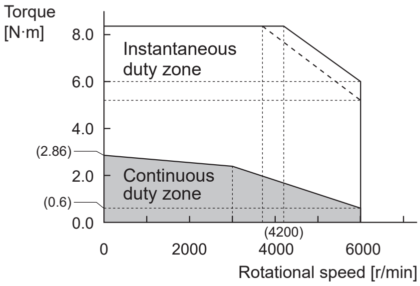
**— Precautions —**

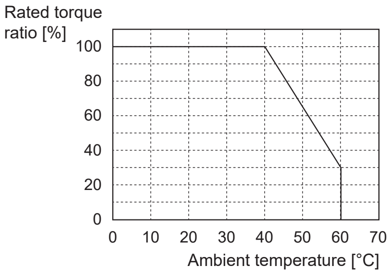
- Use in a location where the temperature at the center of the motor frame is below 75°C (750 W) or 85°C (1000 W) (When the ambient temperature is 40°C at an altitude of 1000 m or less).

#### ■ S-T characteristics (representative values)

Servo driver power supply voltage: For 200 V AC (dotted line indicates 10% drop in power supply voltage)

- MHMG082U1□ △ Without oil seal

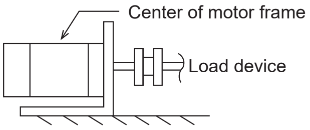




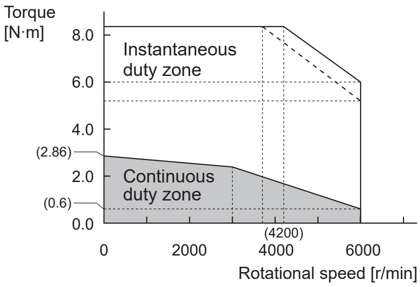
Measurement conditions

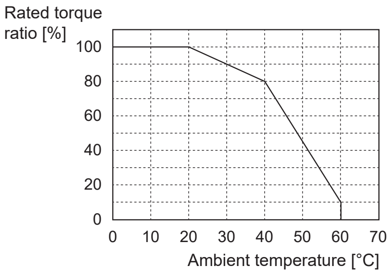
Flange size: 170 × 160 × t12

Material: Aluminum



- MHMG082U1□△ With oil seal

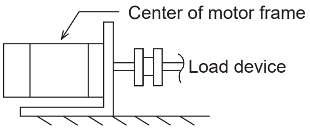




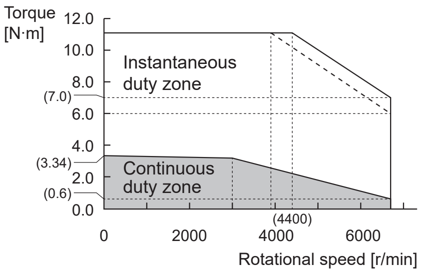
Measurement conditions

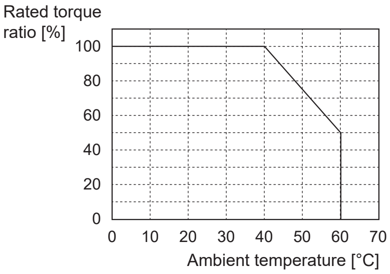
Flange size: 170 × 160 × t12

Material: Aluminum



- MHMG092U1□ △ Without oil seal

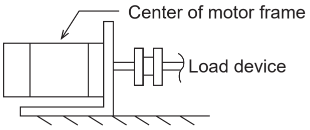




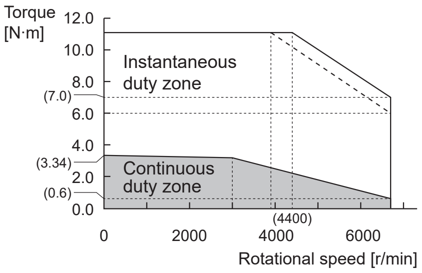
Measurement conditions

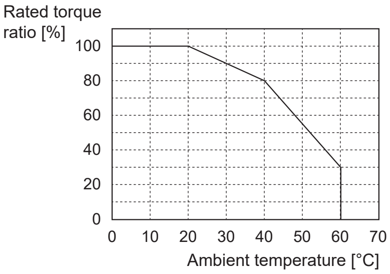
Flange size: 170 × 160 × t12

Material: Aluminum



- MHMG092U1□△ With oil seal

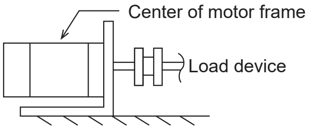




Measurement conditions

Flange size: 170 × 160 × t12

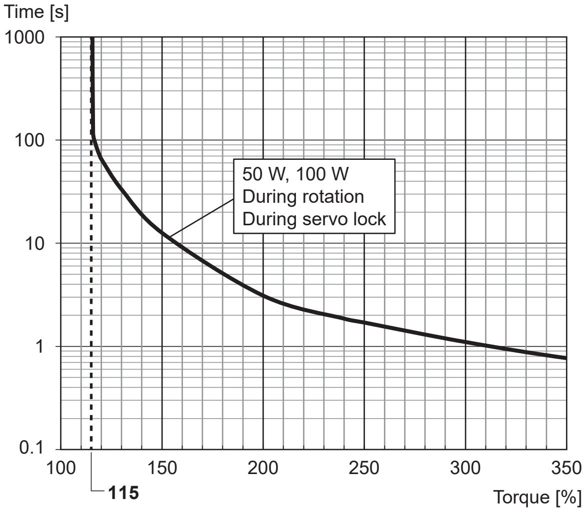
Material: Aluminum



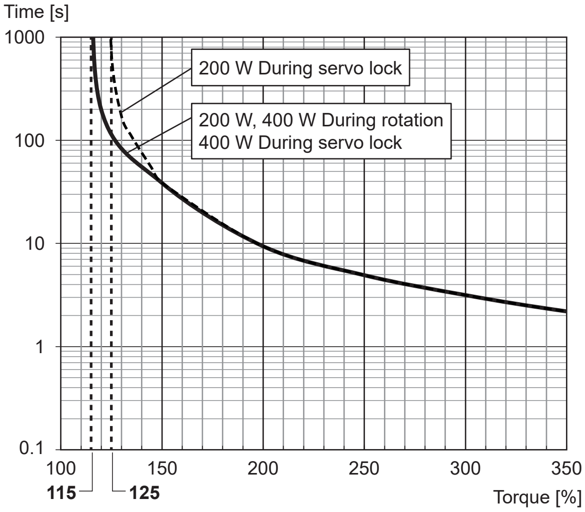
## 2.2.5 Overload Protection Time Characteristics (Motor)

Overload protection time characteristics (motor) are shown below.

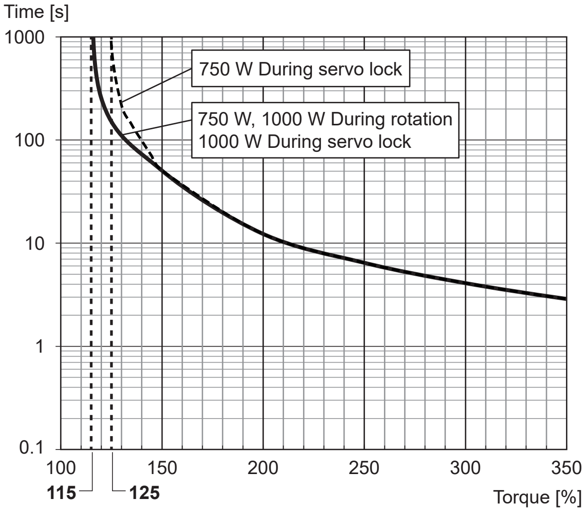
**MHMG5AZU1☐△, MHMG011U1☐△, MHMG012U1☐△**



**MHMG021U1☐△, MHMG022U1☐△, MHMG041U1☐△, MHMG042U1☐△**



**MHMG082U1☐△, MHMG092U1☐△**



**— Precautions —**

- The above time characteristics use our standard servo drivers.

  Ensure that the effective torque is within the continuous duty zone of the S-T characteristics of each motor.

  For "S-T characteristics", see *“2.2.4 Specifications”* .
- When used in combination with a servo driver other than our standard servo driver, ensure that the overload setting for the servo driver is below the time characteristics stated above.

  Please contact us for the time characteristics of specific models.

## 2.3 Driver and Motor Combinations

Driver and motor combinations are shown in the table below.

Check the applicable motor series name, rated output, voltage specification and encoder specifications and use the correct combination.

**— Precautions —**

- Do not use in other combinations than those listed in the table below.

| Motor | | | | | Driver | |
|---|---|---|---|---|---|---|
| Power supply | Type | Rated rotating speed | Product number [*1] | Rated output | Type product number [*1] | Size |
| Single phase<br>100 V | MHMG<br>High inertia | 3000 r/min | MHMG5AZU1□2□ | 50 W | MADN061□□ | A |
| | | | MHMG011U1□2□ | 100 W | MADN081□□ | |
| | | | MHMG021U1□2□ | 200 W | MBDN121□□ | B |
| | | | MHMG041U1□2□ | 400 W | MCDN201□□ | C |
| Single phase/3-phase<br>200 V | | | MHMG5AZU1□2□ | 50 W | MADN065□□ | A |
| | | | MHMG012U1□2□ | 100 W | | |
| | | | MHMG022U1□2□ | 200 W | MADN085□□ | |
| | | | MHMG042U1□2□ | 400 W | MBDN125□□ | B |
| | | | MHMG082U1□2□ | 750 W | MCDN205□□ | C |
| | | | MHMG092U1□2□ | 1000 W | MDDN405□□ | D |

[*1] The "□" in the model number represents the difference in specification.

## 2.4 Absolute Encoder (Battery Backup)

### 2.4.1 Overview

The absolute encoder is an encoder that can back up motor position information when the power supply is off.

A system using an absolute encoder is called an "absolute system". The absolute system eliminates the need for homing operations when the power is on and can be useful for robots and other applications.

For details on how to use absolute encoders, see *“7.2.7 Absolute Encoder”* .

There are two types of absolute encoder as described below.

- Absolute encoder (battery backup)
- Batteryless absolute encoder

The absolute encoder (battery backup) requires the connection of an absolute encoder battery to back up multi-turn data.

*“2.4”* section mainly describes this absolute encoder (battery backup).

### 2.4.2 Battery for Absolute Encoder

When using the optional battery unit provided by our company, install, replace, and set up (initialize) batteries in an absolute system using an absolute encoder (battery backup) according to the following procedure.

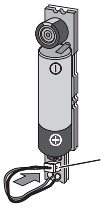
For details of battery product numbers and specifications, see *“12.4.9 Battery for Absolute Encoder”* .

### 2.4.2.1 How to Install Batteries (How to Install to Encoder Junction Cable)

Follow the procedure below to install batteries.

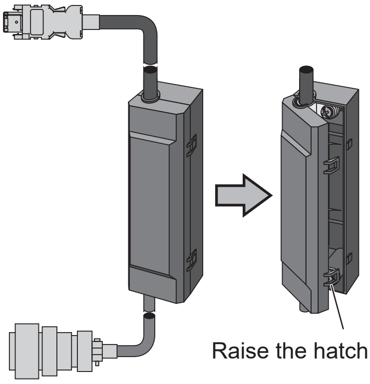
**<< Procedure >>**

1. Perform a refresh of the new battery.

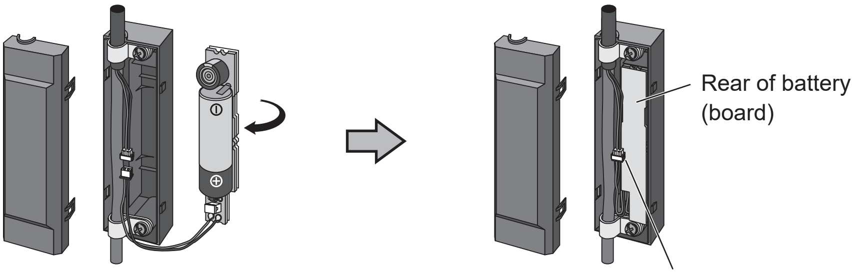


Connect the connector with battery lead wire to CN601 and leave for 5 minutes.
After five minutes, remove the connector from CN601.

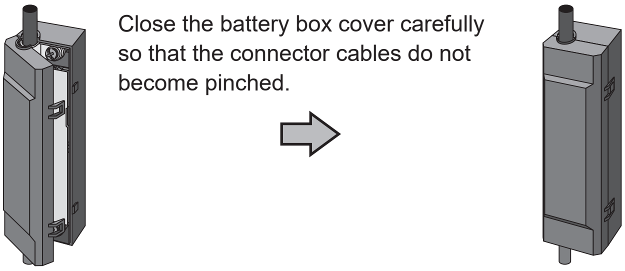
2. Remove the battery box cover.



3. Install the battery to the battery box.



4. Close the cover of the battery box.



**— Precautions —**

- Using batteries incorrectly may result in product corrosion due to battery leakage and in damage to the battery. When using batteries, be sure to observe the following.
  1. The positive and negative poles of the battery must be correctly oriented and the CN601 connector with lead wires must be correctly connected.
  2. Because leaving batteries that have been used for long periods of time or that are no longer usable inside the device may cause problems such as leaks, make sure to replace them promptly. (Replacement is recommended roughly every two years). The electrolyte in the battery is highly corrosive and can corrode peripheral parts. It is also conductive and can cause issues such as short circuits. Therefore, make sure to replace the battery periodically.
  3. Do not attempt to disassemble the battery or place it in a fire. Do not attempt to disassemble the battery as it is very dangerous if contents are splashed into your eyes. It may also explode if put into a fire or heated.
  4. Do not short-circuit the battery. Do not remove the battery tube. If metal or other such materials come into contact with the positive or negative pole terminals of the battery, a large current flows all at once, which would not only weaken the battery, but also generate severe heat and possibly cause the battery to explode.
  5. Do not attempt to charge it. This battery cannot be charged.

- Disposal of batteries after replacement is regulated by municipalities in some cases. Please dispose of batteries according to local regulations.
- Applications for shipment as a hazardous material may be required for air shipments (both passenger and cargo aircraft). Consult with the shipping company when requesting air shipments.

#### 2.4.2.2 First Installation of the Battery

After installing and connecting the absolute encoder battery to the motor, set up the absolute encoder. For details, see *“2.4.3 Setup (Initialization) of Absolute Encoder”* .

We recommend turning the control power supply ON/OFF (battery refresh operation) after installing the battery for the absolute encoder. For details on refreshing the battery, see *“2.4.2.3 Battery Refresh (Method Using Set-up Support Software (PANATERM ver.7) )”* .

Lithium batteries have a transient minimum voltage (voltage delay phenomenon), which causes a temporary voltage drop when the battery begins to discharge current. A battery error might occur due to this phenomenon if you fail to refresh the battery.

We recommend that the battery be refreshed about once a day after the battery unit is installed.

We also recommend that you refresh the battery even if you have prepared it yourself. Please consult with the battery manufacturer regarding the method of doing so.

A voltage drop in the battery may be primarily caused by battery life. Battery life may be shortened depending on ambient conditions.

#### 2.4.2.3 Battery Refresh (Method Using Set-up Support Software (PANATERM ver.7) )

If the battery (battery for absolute encoder) is not discharged continuously, a battery alarm may be triggered. Perform the battery refresh process (forced discharge) to prevent this from happening.

The battery refresh process is required in cases such as the following:

- When replacing with a new battery
- When operating after a period of inactivity

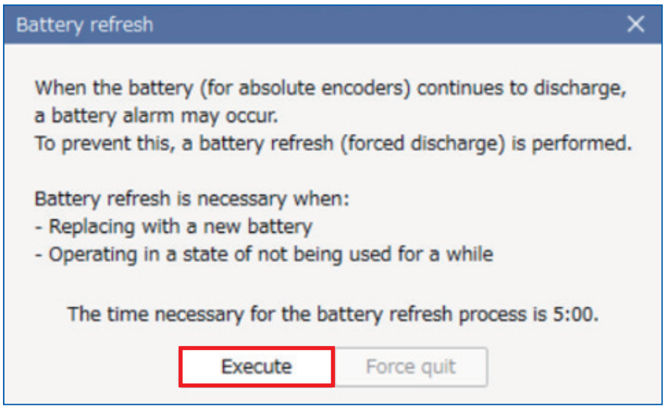
**<< Procedure >>**

1. Right-click on the motor information area of the device tree and select “Battery Refresh” from the context menu.

Right-click on Motor Information area

The Battery Refresh dialog box appears.

2. Click the "[Execute]" button.



Battery refresh

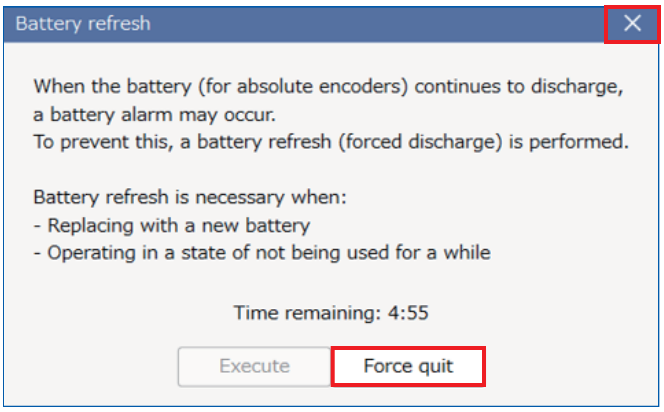
When the battery (for absolute encoders) continues to discharge, a battery alarm may occur.
To prevent this, a battery refresh (forced discharge) is performed.

Battery refresh is necessary when:
- Replacing with a new battery
- Operating in a state of not being used for a while

The time necessary for the battery refresh process is 5:00.

The remaining time for the battery refresh process will start counting down.

3. The battery refresh process starts.



Battery refresh

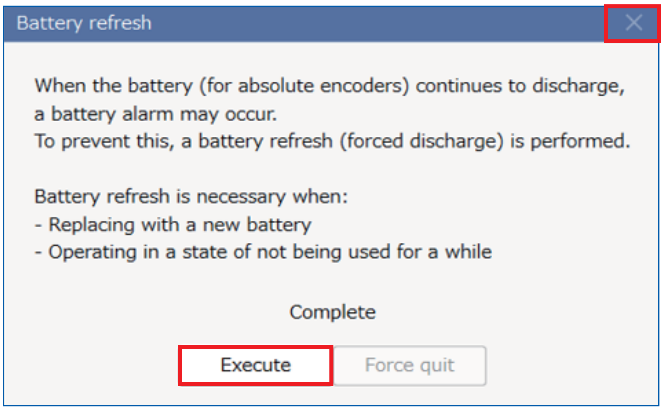
When the battery (for absolute encoders) continues to discharge, a battery alarm may occur.
To prevent this, a battery refresh (forced discharge) is performed.

Battery refresh is necessary when:
- Replacing with a new battery
- Operating in a state of not being used for a while

Time remaining: 4:55

For clicking the [Force Quit] button during the battery refresh process, see“Step 5”. For clicking the [×] button, see“Step 6”.

4. The following screen will appear once the battery refresh process is complete.
   Click the [Execute] button to refresh the battery again, or click the [×] button to exit.



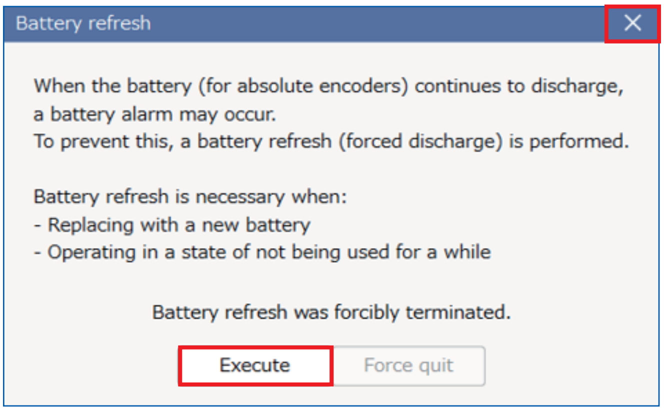
Battery refresh

When the battery (for absolute encoders) continues to discharge,
a battery alarm may occur.
To prevent this, a battery refresh (forced discharge) is performed.

Battery refresh is necessary when:
- Replacing with a new battery
- Operating in a state of not being used for a while

Complete

5. Clicking the [Force Quit] button during the battery refresh process forcefully terminates the battery refresh process. Click the [Execute] button to refresh the battery again, or click the [×] button to exit.



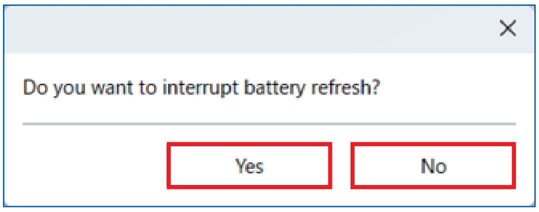
Battery refresh

When the battery (for absolute encoders) continues to discharge,
a battery alarm may occur.
To prevent this, a battery refresh (forced discharge) is performed.

Battery refresh is necessary when:
- Replacing with a new battery
- Operating in a state of not being used for a while

Battery refresh was forcibly terminated.

6. Clicking the [×] button during battery refresh displays a dialog box.
   Clicking the [Yes] button will cancel the battery refresh process and return you to main screen operations.
   Clicking the [No] button will return you to main screen operations while the battery refresh process continues.



Do you want to interrupt battery refresh?

**— Precautions —**

- The battery refresh process is not available for batteryless or incremental encoders.
- The battery refresh process cannot be used in full-closed control mode.
- Be aware that a battery alarm may be triggered. during the battery refresh process.

### 2.4.2.4 Replacement of the Battery

It is necessary to replace the absolute encoder battery if a battery warning occurs.

Replace the battery with the driver control power ON. Data stored in the encoder might be lost if you replace the battery while the control power of the driver is OFF.

After replacing the absolute encoder battery, clear the battery warning. Click the warning clear button on the Set-up Support Software (PANATERM ver.7) monitor display window to clear alarms, or do so via EtherCAT communication.

**— Precautions —**

- If you clear the absolute encoder rather than the alarm, all error and multi-turn data will be cleared together with the warning.

### 2.4.2.5 Battery Life

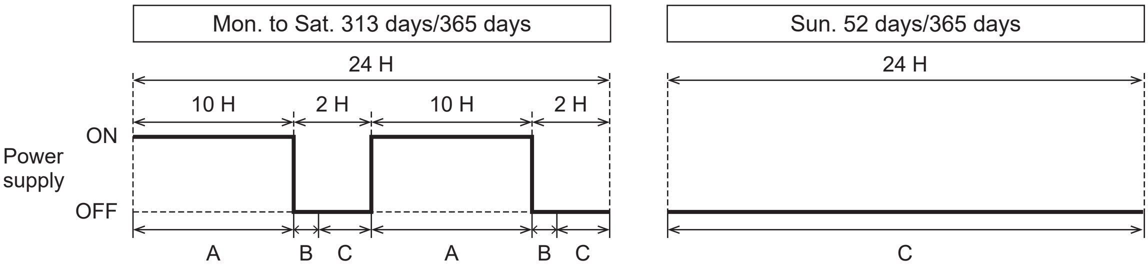
The following example shows the life calculation of the absolute encoder battery used, assuming robot operation.

Calculated with a battery capacity of 2000 mAh. Note that the following value is not a guaranteed value, but only represents a calculated value.

**— Precautions —**

- The values below were calculated with only the current consumption factored in. The calculations do not factor in electrolyte leakage and other forms of battery deterioration. Lifetime may be shortened depending on ambient condition.

1 Example of operation of 2 cycles/day



A: Battery current consumption in normal mode (0 μA)
B: Battery current consumption in power failure timer mode (90 μA)
C: Battery current consumption in power failure mode (30 μA)

Consumption capacity per year =
(10H×A + 0.0014H×B + 2H×C)×2×313 days + 24H×C×52 days
= 75.1 mAh
Battery life = 2000 mAh/75.1 mAh/year = 26.6 years

2 Example of operation of 1 cycle/day

The following shows an example of battery life calculations when two cycles in “1” above is set to rest.

Consumption capacity per year =
(10H×A + 0.0014H×B + 14 H×C)×313 days + 24H×C×52 days
= 168.9 mAh
Battery life = 2000 mAh/168.9 mAh/year = 11.8 (11.841) years

### 2.4.2.6 When Making Your Own Cable for Absolute Encoders (Battery Backup)

When you make your own cable for the absolute encoder (battery backup), connect the optional absolute encoder battery as per the wiring figure. The customer must also provide their own connectors for connecting absolute encoder batteries.

**— Precautions —**

- Install and fix batteries securely. If the installation and fixing of the battery is not appropriate, it may cause wire malfunction or damage to the battery.

  For details on handling the battery, see the operating manual of the battery.

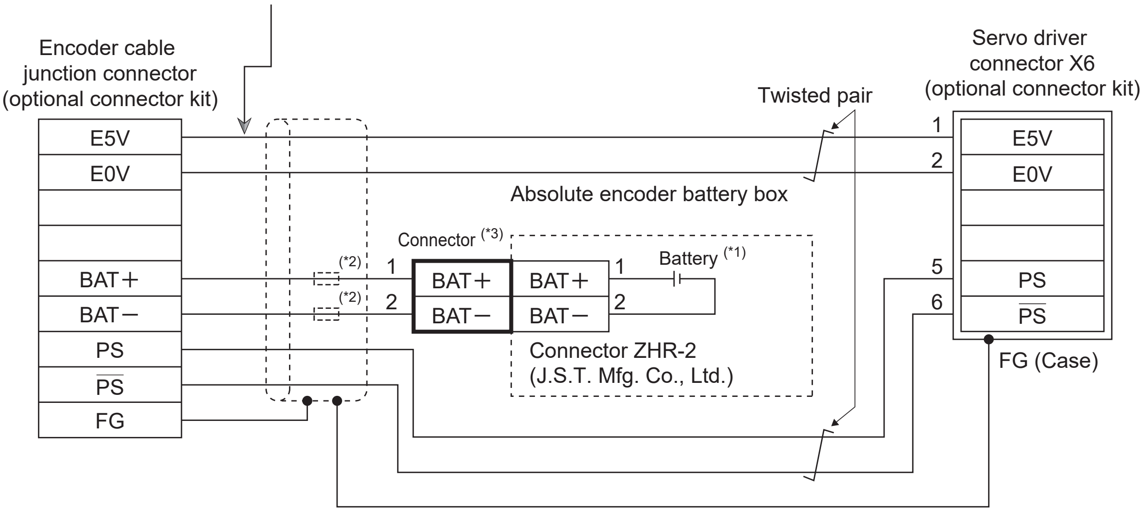
## ■ Where to install batteries

1. Indoors, where the products are not subjected to rain or direct sunlight
2. Where the products are not subjected to corrosive atmospheres such as hydrogen sulfide, sulfurous acid, chlorine, ammonia, sulfur, chloride gas, sulfuric gas, acid, alkaline and salt and so on, as well as places where they are not subjected inflammable gas, grinding fluid, oil mist, iron powder, chips, etc.
3. Somewhere well-ventilated and humid and dust-free
4. Somewhere free from vibrations

## ■ Wiring diagram

Pin numbers of optional connector

| | | E5V | E0V | BAT+ | BAT- | PS | PS | FG |
|---|---|---|---|---|---|---|---|---|
| Small motor | Lead wire type | 7 | 8 | 1 | 2 | 4 | 5 | 3 |



*1 Battery for absolute encoder

*2 Join the encoder side connector and battery side connector with solder, as the applicable electric wire diameters are different.

*3 Connectors for connecting absolute encoder batteries

| Name | Product number | Manufacturer |
|---|---|---|
| Connector | ZMR-2 | J.S.T. Mfg. Co., Ltd. |
| Connector pin | SMM-003T-P0.5 | J.S.T. Mfg. Co., Ltd. |
| Recommended manual clamping jig | YRS-800 | J.S.T. Mfg. Co., Ltd. |

See *"12.4.9 Battery for Absolute Encoder"* for information on optional parts such as absolute encoder batteries, connectors for connecting absolute encoder batteries, and boxes for absolute encoder batteries.

### 2.4.3 Setup (Initialization) of Absolute Encoder

Absolute multi-turn data is retained by the absolute encoder battery. When operating the machine for the first time after installing an absolute encoder battery, you must clear the absolution encoder data (multi-turn data) to 0 at the origin by clearing the encoder at the home position. This clearing operation is called "multi-turn data clear".

Multi-turn data is cleared with Set-up Support Software (PANATERM ver.7) or EtherCAT communication. After performing the multi-turn data clearing operation, turn off the control power supply once, and then turn it back on.

For the method and procedure for clearing the multi-turn data using EtherCAT communication, check the host device specifications.

# 3 Installing and Connecting the Driver and Motor

## 3.1 Installation

This section contains information required for the installation of drivers and motors.

Install drivers and motors properly to avoid malfunctions or accidents.

### 3.1.1 Driver Installation

#### 3.1.1.1 Installation Location

Please observe the following items when selecting a location to install the driver.

- The product is not waterproof. Install the driver in a control panel enclosed in noncombustible materials and placed indoors where the product is not subjected to rain or direct sunlight. The control board should be made of metal and ensure that it is electrically conductive.
- Install the driver in a location where it will not be exposed to grinding fluid, oil mist, iron powder, or chips.
- Install the driver in a well-ventilated location with low humidity and little dust or debris.
- Install in a vibration-free location.
- Avoid installing the driver near corrosive atmospheres such as hydrogen sulfide, sulfurous acid, chlorine, ammonia, sulfur, chloric gas, sulfuric gas, acid, alkali, and salt, as well as near atmospheres of inflammable gas, atmospheres where helium gas or other gases with small molecular weight are generated, or near combustible materials.

#### 3.1.1.2 Environmental Conditions

Please observe the following items when selecting an environment in which to use the driver.

| Item | Condition |
|---|---|
| Operating temperature | 0°C to 60°C (it must not freeze)<br>(Can be used between 55°C and 60°C when derated (*3) ) |
| Operating humidity | 20% to 85% RH (free from condensation (*2) ) |
| Storage temperature (*1) | -20°C to 65°C<br>(Max. temperature guarantee: 80°C for total of 72 hours, free from condensation (*2) ) |
| Storage humidity | 20% to 85% RH (free from condensation (*2) ) |
| Vibration | 5.88 m/s$^2$ (0.6 G) or less, 10 to 60 Hz |
| Altitude | 2000 m or less (can be used at 1000 to 2000 m when derated (*3) ) |

*1 Extreme temperatures are allowable only for short periods such as during transportation.

*2 Please note that condensation is more likely to occur when the temperature drops and humidity rises.

*3 For details on derating, see *“2.1.4.1 Basic Specifications”* .

### 3.1.1.3 How to Install

Please observe the following items when installing the driver.

- This is a vertically mounted product. Please install vertically.
- Sizes A to D drivers are base-mounted drivers (rear-mounted).
- To change the mounting surface of Sizes A to D drivers, use the optional mounting bracket. During installation, use the mounting screws provided with the product and the following tightening torque.
  - 1.0 to 1.35 N·m

  For optional mounting brackets, see *“12.4.10 Mounting Bracket”* .
- Apply adequate tightening torque to the product mounting screws by taking into consideration the strength of the screws and the characteristics of the material to which the product is installed.

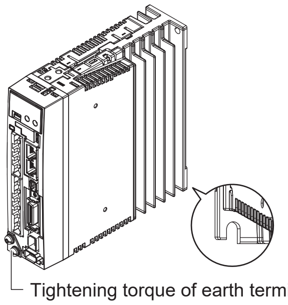
  (Example) Fastening to steel with steel screws

  Sizes A to D: M5 2.7 to 3.3 N·m

  Sizes A to D: M5 2.7 to 3.3 N·m installation is shown below.

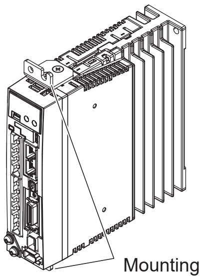
Sizes A to D

Base mount (Standard)
[Rear mount]



Tightening torque of earth terminal (M4) to be 0.7 N·m to 0.8 N·m.

Front mount
[Use mounting bracket]



Mounting bracket (optional)

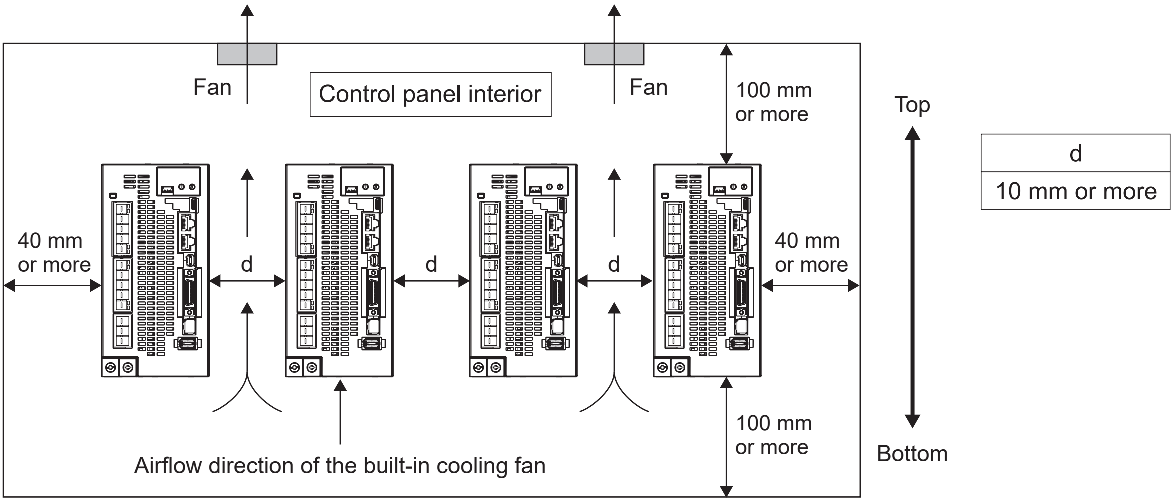
**— Precautions —**

- In order to prevent noise, it is recommended that conductive plating is used at the location where the driver is to be mounted. If the driver mounting points are painted, removing the paint before installation may help to prevent noise. When making your own mounting brackets, use conductive plating.

### 3.1.1.4 Mounting Orientation and Intervals

Please observe the following heat protection measures for the driver.

- Ensure sufficient surrounding space for effective cooling. For installation intervals, see the below diagram.
- Install a fan to achieve a uniform temperature within the control panel.
- Size D is equipped with a cooling fan on the bottom of the servo driver.
- Observe *“3.1.1.2 Environmental Conditions”* for the control panel internal environmental conditions.
- Check that the ambient temperature within 50 mm of the servo driver does not exceed the operating temperature range.
- If it is not possible to measure the temperature from a distance of 50 mm, instead measure at the midpoint of the gap between the obstacle preventing measurement and the servo driver.



**Notes**

- Can be used derated when mounting interval d is 1 to 10 mm. For details on derating, see *"2.1.4.1 Basic Specifications"* .

**— Precautions —**

- Owing to the possibility, however unlikely, that your finished equipment will operate abnormally due to a malfunction of our product (such as due to signal disconnections, signal open phases, or operation performed outside the settings as a result of external noise or static electricity being applied), put in place fail-safes and ensure adequate safety within the operational range of your site.
- When using stranded electric wires, use insulated ferrule terminals or insulated round terminals. If stranded wires are used as-is, it can result in unexpected accidents or injuries such as electric shock and short circuits.
- Be sure to install a molded-case circuit-breaker to the power supply. Make sure to ground the earth terminals and earth wires. In order to prevent electric shock and malfunctions, Class D grounding or higher (grounding resistance of 100 Ω or less) is recommended. If not properly grounded, not only might the driver not deliver sufficient performance, but safety hazards such as malfunctions due to electrification or disturbances may arise.
- Binding and inserting wires into a metal duct will cause the temperature to increase, resulting in reduced allowable current values for the cables, possibly leading to burning. Consider the current reduction coefficient before deciding on how to wire the product.
- Ensure that the product is wired correctly and securely. Insecure or improper wiring may cause the motor to go out of control or burn. Ensure that no conductive material such as wire debris enters into the driver during installation and wiring.
- Be sure to tighten terminal block and ground screws properly using the torques specified in *"1.8.2.3.3 Wiring Terminal Blocks and Earth Terminals"* .
- Do not approach the motor or a machine being driven by the motor when the power is on to ensure safety in the event of an unexpected malfunction.
- Do not start or stop the device by turning the servo-on signal on or off. Doing so may damage the built-in dynamic brake circuit in the driver.
- Take care to ensure that the ambient temperature of the driver is within the operating range. The driver emits heat while the motor is in operation. Using the driver in a sealed control box may cause abnormal heating of the control box.
- Malfunctions of the motor or the driver it is combined with may result in burns to the motor and the emission of smoke and dust in an amount equivalent to roughly one cigarette. Please consider these possibilities when using the device in cleanrooms and similar facilities.

- The capacity of the capacitors of the power supply rectifier circuit will drop over time. To avoid a secondary problem due to malfunction, replacement is recommended approximately every five years. Replacement must be carried out by Panasonic or an authorized dealer.
- If the dynamic brake is applied when the device is operating at high speed, allow a stop time of approximately 10 minutes. Restarting the motor earlier may cause a broken wire in the dynamic brake making the brake inoperable.

## 3.1.2 Motor Installation

### 3.1.2.1 Installation Location

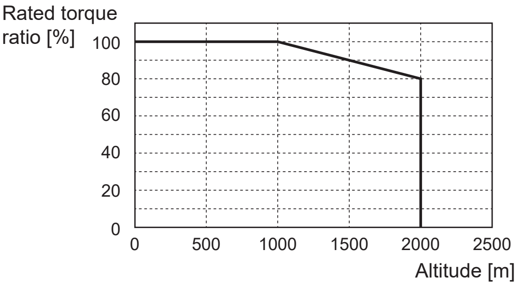
Whether the installation location is good or bad greatly affects the life expectancy of the motor, so be sure to select a location that meets the following conditions.

- Install the motor indoors, where it is not subjected to rain or direct sunlight.
- Install the driver in a location where it will not be exposed to grinding fluid, oil mist, iron powder, or chips.
- Install the motor in a well-ventilated location with minimal infiltration of moisture, oil, or water, and away from furnaces or other heat sources.
- Install in a location with easy access for inspection and cleaning.
- Install in a vibration-free location.
- Avoid using the motor in enclosed spaces, and install it in a well-ventilated space. The motor may overheat in enclosed spaces, shortening the motor’s life.
- Avoid installing the driver near corrosive atmospheres or atmospheres of inflammable gas such as hydrogen sulfide, sulfurous acid, chlorine, ammonia, sulfur, chloric gas, sulfuric gas, acid, alkali, and salt, atmospheres where helium gas or other gases with small molecular weight are generated, or near combustible materials.

### 3.1.2.2 Environmental Conditions

Please observe the following items when selecting an environment in which to use the motor.

| Item | | Condition |
|---|---|---|
| Operating temperature (*1) | | Allowable ambient temperature (Except for motor temperature rise)<br>During operation : 0 °C to 60 °C (free from condensation (*4) )<br>However, in the following cases, be sure to perform the derating indicated in *“2.2.4 Specifications”* specifications and Speed-Torque characteristics.<br>● Motors without oil seals, when the temperature exceeds 40 °C<br>● Motors with oil seals, when the temperature exceeds 20 °C |
| Operating humidity | | 20% to 85% RH (free from condensation (*4) ) |
| Storage temperature (*2) | | -20°C to 65°C<br>(Max. temperature guarantee: 80°C for total of 72 hours, free from condensation (*4) ) |
| Storage humidity | | 20% to 85% RH (free from condensation (*4) ) |
| Vibration resistance | Motor only | 49 $m/s^2$ or less during rotation in X, Y, and Z directions<br>(Frame median: 20–3000 Hz, amplitude: 1.5 mm or less)<br>24.5 $m/s^2$ or less when stopped |
| Impact resistance | Motor only | 98 $m/s^2$ or less in X, Y, Z directions 3 times each (with flange surface as reference) |
| IP rating (*3) | Motor only<br>(Lead wire type) | IP65 (Except for shaft through sections and connector sections) |

| Item | Condition |
|---|---|
| Altitude | 2000 m or less<br>However, be sure to perform the derating shown below when using at altitudes in excess of 1000 meters.<br> |

*1 The operating temperature is the temperature 5 cm away from the motor.

*2 Extreme temperatures are allowable only for short periods such as during transportation.

*3 These motors conform to the test conditions specified in the EN 60529 and EN 60034-5 standards. Not applicable for applications that require waterproof performance over extended periods of time, such as constant washing in water.

*4 Please note that condensation is more likely to occur when the temperature drops and humidity rises.

### 3.1.2.3 How to Install

You can mount the motor either horizontally or vertically as long as you observe the following.

- Horizontal mounting

  Mount the motor with the cable outlet facing downward as a countermeasure against water and oil.

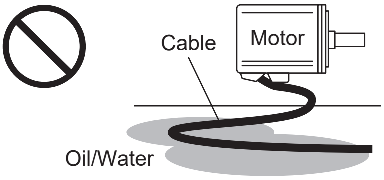
- Vertical mounting

  Use a motor with an oil seal when mounting a motor with a gear reducer to the axis upward to prevent the reducer oil from entering the interior of the motor.

### 3.1.2.4 Oil/Water Protection

Please observe the following items to protect the motor from oil and water.

- Do not use with the cable immersed in oil or water.



- Install the motor with the cable outlet facing downward.
- Do not use in an environment where the motor is constantly exposed to oil or water.
- When combining with a gear reducer, use a motor with an oil seal to prevent oil from entering the motor through the axis.

### 3.1.2.5 Stress to Cables

Please observe the following items to avoid stressing the cables.

- Avoid applying stress to the cable outlet and connecting portion by bending or its own weight.
- Especially in applications where the motor itself moves, fix the relay cable into the cable bear so that the stress by bending can be minimized.
- Make the cable bending radius as large as possible. (When using our optional cable, minimum R20 mm)

### 3.1.2.6 Permissible Load of Motor Output Axis

The mechanical system must be designed so that the applied radial load and/or thrust load to the motor axis at installation and at normal operation can meet the allowable value specified for each model.

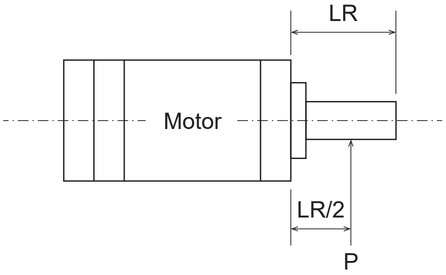
Pay extra attention when using rigid coupling, as excessive bending loads may cause the axis to break and reduce bearing life.

In order to keep the radial load caused by slight misalignment below the allowable value, use flexible coupling with the highest possible stiffness designed exclusively for the motor.

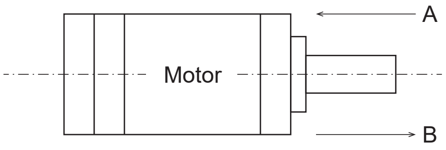
For the permissible load at output axis for each motor series, see the table below.

For measurement (LR) details, see the dimension diagram ( *“12.2 Dimensions”* ).

Radial load (P) position



Thrust load direction

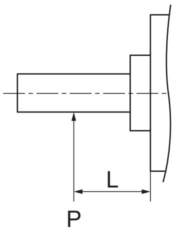


Unit: [N]

| Motor series | Motor output | During assembly | | | During operation | |
|---|---|---|---|---|---|---|
| | | Radial load | Thrust load | | Radial load | Thrust load |
| | | | A-direction | B-direction | | |
| MHMG | 50 W | 147 | 88 | 117 | 68 | 58 |
| | 100 W | | | | | |
| | 200 W | 392 | 147 | 196 | 245 | 98 |
| | 400 W | | | | | |
| | 750 W | 686 | 294 | 392 | 392 | 147 |
| | 1000 W | | | | | |

**Notes**

- When the load position is changed, calculate the allowable radial load P (N) using the relational expressions shown in the table below. When doing so, use load position distance L (mm) from the mounting flange surface and set the load to a value less than or equal to the calculated result.



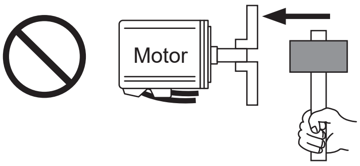
| Applicable models | Motor output | Relational expressions for load-to-load position |
|---|---|---|
| MHMG | 50 W | $P=\frac{2658}{L+26.3}$ |
| | 100 W | $P=\frac{3499}{L+38.5}$ |

| Applicable models | Motor output | Relational expressions for load-to-load position |
|---|---|---|
| MHMG | 200 W | $P=\frac{13402}{L+39.7}$ |
| | 400 W | $P=\frac{17432}{L+56.2}$ |
| | 750 W | $P=\frac{29949}{L+58.9}$ |
| | 1000 W | $P=\frac{34339}{L+70.1}$ |

### 3.1.2.7 Other Precautions

Please observe the following items when installing the motor.

- Do not apply direct impact to the axis with a hammer or similar tool while attaching or detaching a coupling to or from the motor axis (Doing so may damage the encoder mounted on the other side of the axis).



- Perform full alignment (Incomplete alignment may cause vibration and damage the bearing.).
- Ensure that the motor axis is not operated without being electrically grounded, as this may lead to the electrolytic corrosion of the motor bearing and increased bearing noise, depending on the machine and the installation environment. Confirmation and verification by the customer is required.

## 3.2 Connections

### 3.2.1 Wiring to the Main Circuit

The following will be described in each section.

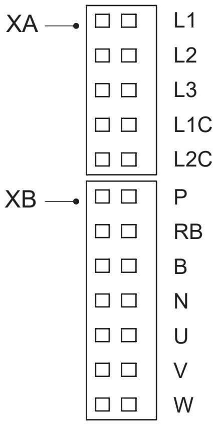
- Connector specifications: Terminal names, symbols, and descriptions of Connectors XA and XB. There are specific wiring procedures for each product type that must be followed when wiring.
- Example of complete connections: Typical example connection that covers the entire unit.
- Key points on wiring: Key points on wiring and connections.
- Wiring diagram: Detailed wiring example of the main circuit section. In this manual, all driver connector pinout diagrams are from an external view of the driver.

### 3.2.1.1 Sizes A, B (100 V/200 V)

#### 3.2.1.1.1 Connector Specifications

Connect main power supply and control power to XA. Connect motor and regenerative resistor to XB.

**Pinout diagram**



| Name | | | Symbol | Connector pin no. | Description |
|---|---|---|---|---|---|
| Connector | XA | Main power supply input terminal | L1 | 1 | 100 V system: Input single-phase 100 to 120 V +10%/-15% 50/60 Hz.<br>200 V system: Input single-phase/three-phase 200 to 240 V +10%/-15% 50/60 Hz.<br>For single phase, connect to terminals L1 and L3. |
| | | | L2 | 2 | |
| | | | L3 | 3 | |
| | | Control power supply input terminal | L1C | 4 | 100 V system: Input single-phase 100 to 120 V +10%/-15% 50/60 Hz.<br>200 V system: Input single-phase 200 to 240 V +10%/-15% 50/60 Hz. |
| | | | L2C | 5 | |
| | XB | Regenerative resistor connection terminal | P | 1 | When adding an external regenerative resistor, connect the external regenerative resistor (prepared by customer) between P and B. Then, set Pr0.16. to 1 or 2.<br>Do not connect anything to the RB terminal.<br>Do not connect anything to the N terminal. |
| | | | RB | 2 | |
| | | | B | 3 | |
| | | | N | 4 | |
| | | Motor connection terminal | U | 5 | Connect each phase of the motor coil.<br>U: U-phase<br>V: V-phase<br>W: W-phase |
| | | | V | 6 | |
| | | | W | 7 | |
| Earth terminal | | | ⏚ | | Terminal for grounding. There are two terminals. One should be connected to the earth, and the other should be connected to the motor earth wire. |

* Tighten earth screws with a torque of M4: 0.7 to 0.8 N·m.

**Wiring Procedure**

1 Connect the power supply and motor to Connector XA and Connector XB.

2 Connect the wired connector to the driver.

Insert the connector securely until it is locked.

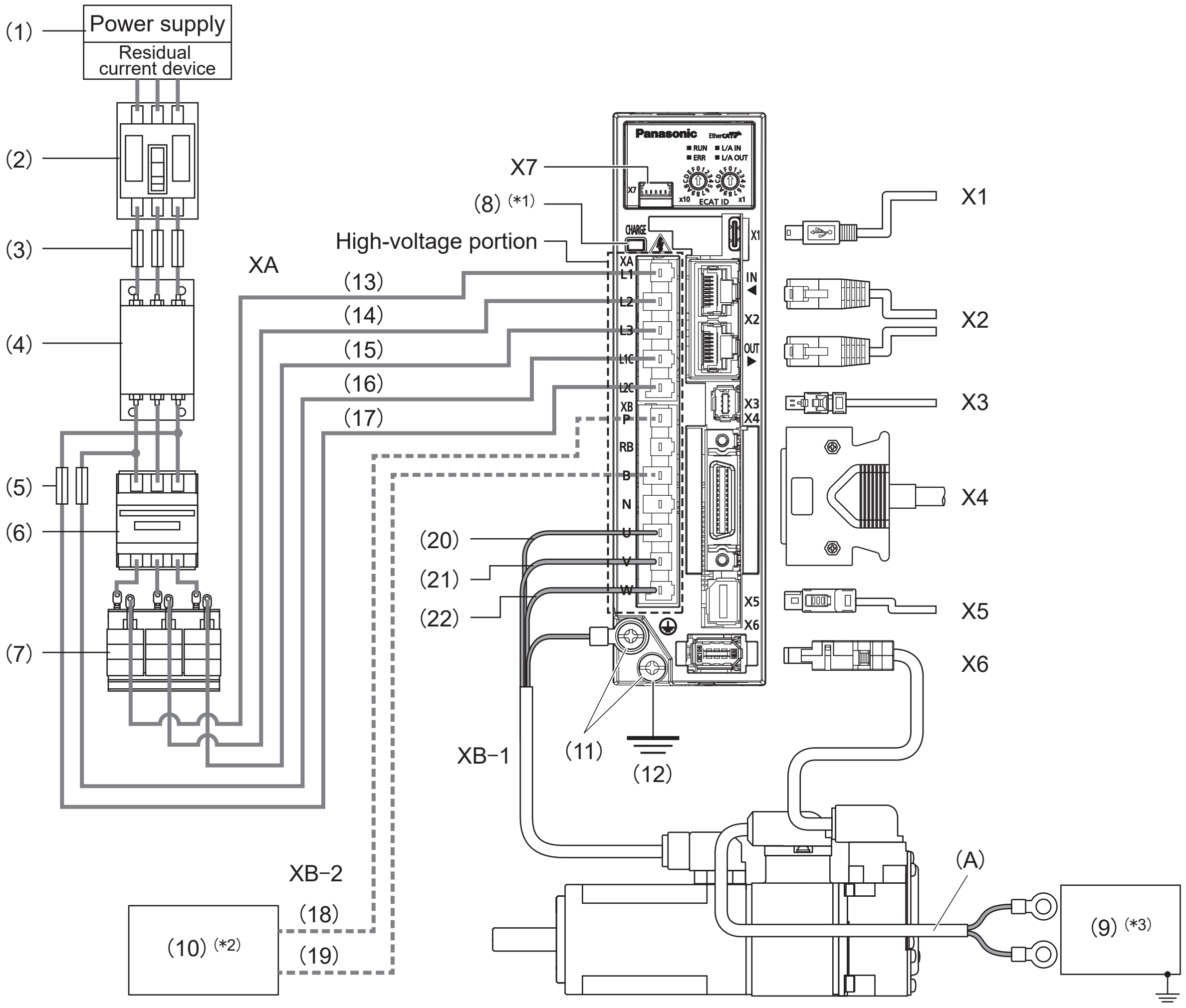
**— Precautions —**

- Wiring should be performed by a qualified electrician.
- In order to prevent electric shocks, do not connect to a power source until the wiring is complete.
- The power connectors (XA and XB) conduct high voltages and carry a risk of electric shock.

**Notes**

- When carrying out wiring work, check *“3.2.1.3 Wiring the Driver XA, XB Connectors”* for the wiring method of the XA and XB power connectors and *“3.2.1.4 Motor Connector Specifications”* for the specifications of the motor connector.

### 3.2.1.1.2 Example Connection for Entire Unit



*1 **Do not move, wire, or inspect the unit when the light is lit. There is a danger of electric shock.**

*2
- **Wire P must be connected to regenerative resistor (18) and wire B to regenerative resistor (19) when connecting to a regenerative resistor (sold separately).**
- **Be sure to install external protection such as a thermal fuse when using an external regenerative resistor.**

- **Each regenerative resistor (sold separately) has a built-in thermal fuse and thermal protector. An activated thermal fuse cannot be restored.**
- **Install the regenerative resistor on nonflammable materials such as metal.**

*3 **X1 to X7 are secondary circuits and must be insulated from the 24 V DC power supply for brakes (9). Do not connect to the same power supply.**

Parts and wiring, etc.

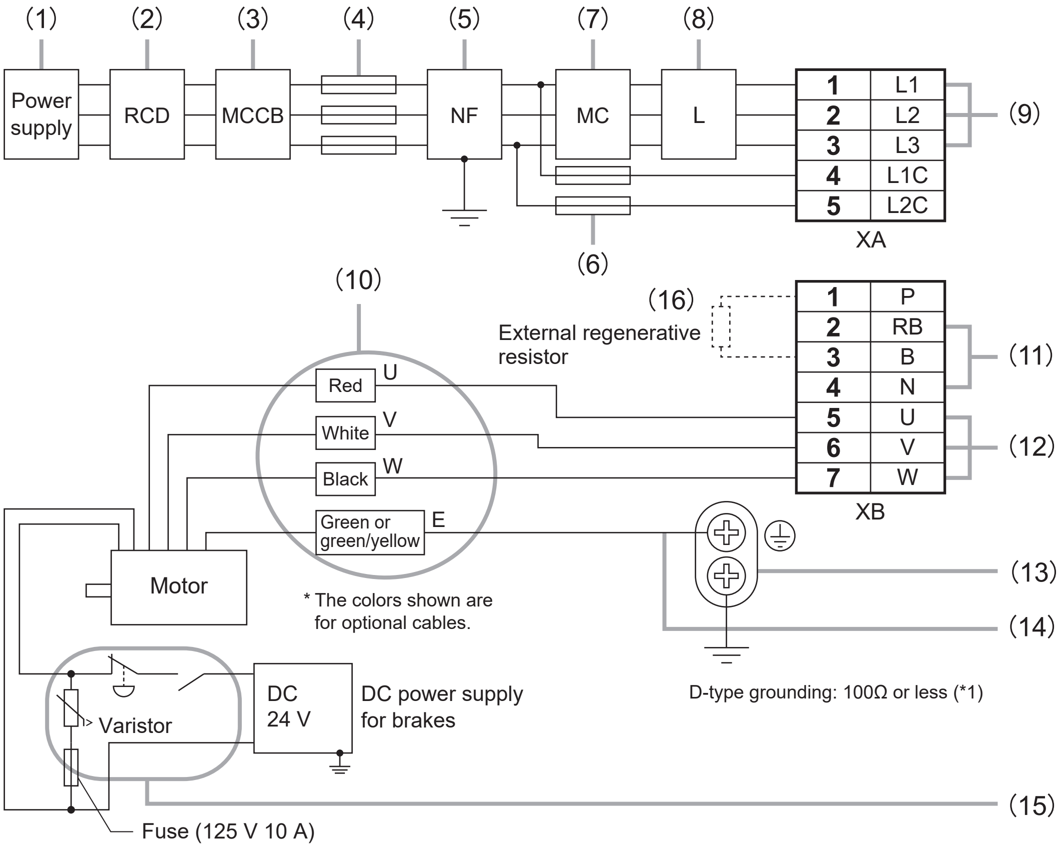
| | | | |
|---|---|---|---|
| (1) | Power supply and residual current device (RCD) | (12) | D-type ground (earth) |
| (2) | Molded-case circuit-breaker (MCCB) | (13) | Main power supply input L1 (1-pin) |
| (3) | Main circuit power supply input line fuse | (14) | Main power supply input L2 (2-pin) |
| (4) | Noise filter (NF) | (15) | Main power supply input L3 (3-pin) |
| (5) | Control circuit power supply input line fuse | (16) | Control power input L1C (4-pin) |
| (6) | Electromagnetic contactor (MC) | (17) | Control power input L2C (5-pin) |
| (7) | Reactor (L) | (18) | Wiring P to the regenerative resistor (1-pin) |
| (8) | Charge lamp (red LED) | (19) | Wiring B to the regenerative resistor (3-pin) |
| (9) | DC power supply for brakes 24 V DC | (20) | U-phase (5-pin, red) (*1) |
| (10) | Regenerative resistor (sold separately) | (21) | V-phase (6-pin, white) (*1) |
| (11) | Earth terminal | (22) | W-phase (7-pin, black) (*1) |

*1 Colors in ( ) are for optional cables.

Connection points for connectors

| | | | |
|---|---|---|---|
| X1 | Connection to computer | X6 | Connection to encoder |
| X2 | Connection with host device (EtherCAT communication) | X7 | Connection to external monitor |
| X3 | Connection to safety controller | XA | Connection to input power |
| X4 | Parallel I/O connection | XB | 1 Connection to motor driving phase and earth<br>2 External regenerative resistor connection |
| X5 | Connection to external scale | (A) | Connection to DC brake power supply |

### 3.2.1.1.3 Key Points on Wiring



*1 For suitable power cables, see *"1.8.2.3 Electric Wires"* .

1 Check the nameplate of the driver for power specifications.

2 Install a residual current device. Use a residual current device with high-frequency countermeasures "for inverters".

3 Install a molded-case circuit-breaker (MCCB).

4 Connect fuses on the main circuit power supply input. See *"1.8.2.13 Installing Short Protection Elements"* when selecting fuse rated currents.

5 Install a noise filter. When using a single phase power supply, always connect to terminals L1 and L3.

6 Connect fuses on the control circuit power supply input line. See *"1.8.2.13 Installing Short Protection Elements"* when selecting fuse rated currents.

7 Install the coil surge absorber recommended by the manufacturer to the coil of the electromagnetic contactor.

Do not start or stop the motor with the electromagnetic contactor.

8 Install an AC reactor.

9 Connect L1 and L1C, and L3 and L2C for single phase use (100 V and 200 V), and do not use L2.

10 Match the colors of the motor lead wires to those of the corresponding motor output terminals (U, V, W).

11 Do not connect anything to "N" and "RB".

12 Avoid shorting and earth faults. Do not connect to the main power supply.

13 Ground. To prevent electric shock, be sure to connect the earth terminal (⏚) of the driver and the earth (earth plate) of the control panel. Do not make multiple connections to one earth terminal (⏚). Two earth terminals are provided.

14 Do not connect earth wires to insertion slots for other wires and do not allow them touch.

15 The holding brake has no polarity. Construct a duplex brake control circuit so that the brake can also be activated by an external emergency stop signal.

For holding brake power supply capacity and use, see *“3.3.1 Internal Brake”* .

Install a varistor. Connect a 10 A fuse in series with the varistor.

16 If connecting an external regenerative resistor, the wiring shown with dotted lines is required.

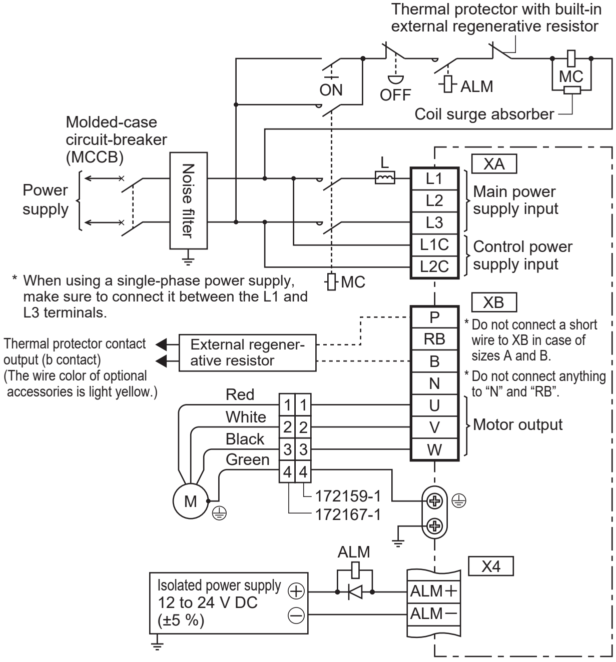
### 3.2.1.1.4 Wiring Diagram

**— Precautions —**

- Configure the circuit so that the main power supply will shut off when an alarm occurs.

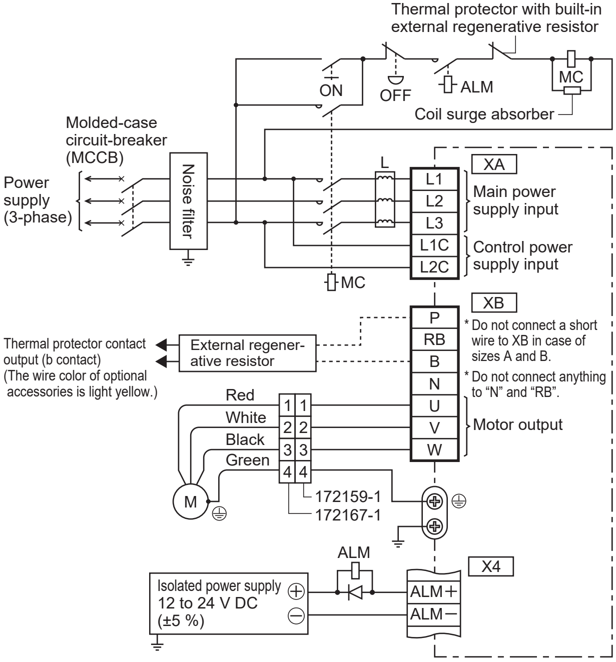
#### Single phase 100 V or 200 V

- Lead wire-type motor



#### 3-phase 200 V

- Lead wire-type motor



**Notes**

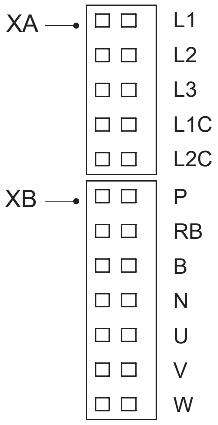
- Sizes A and B are not equipped with regenerative resistors (External only).
  External regenerative resistors can be connected to both sizes A and B.
  If connecting, apply the wiring shown with dotted lines.

### 3.2.1.2 Sizes C, D (100 V/200 V)

#### 3.2.1.2.1 Connector Specifications

Connect main power supply and control power to XA. Connect motor and regenerative resistor to XB.

**Pinout diagram**



| Name | | | Symbol | Connector pin no. | Description |
|---|---|---|---|---|---|
| Connector | XA | Main power supply input terminal | L1 | 1 | 100 V system: Input single-phase 100 to 120 V +10%/-15% 50/60 Hz.<br>200 V system: Input single-phase/three-phase 200 to 240 V +10%/-15% 50/60 Hz.<br>For single phase, connect to terminals L1 and L3. |
| | | | L2 | 2 | |
| | | | L3 | 3 | |
| | | Control power supply input terminal | L1C | 4 | 100 V system: Input single-phase 100 to 120 V +10%/-15% 50/60 Hz.<br>200 V system: Input single-phase 200 to 240 V +10%/-15% 50/60 Hz. |
| | | | L2C | 5 | |
| | XB | Regenerative resistor connection terminal | P | 1 | Normally, short the circuit between RB and B.<br>When adding an external regenerative resistor, disconnect the short wire between RB and B, connect the external regenerative resistor between P and B, and set Pr0.16 to 1 or 2.<br>Do not connect anything to the N terminal. |
| | | | RB | 2 | |
| | | | B | 3 | |
| | | | N | 4 | |
| | | Motor connection terminal | U | 5 | Connect each phase of the motor coil.<br>U: U-phase<br>V: V-phase<br>W: W-phase |
| | | | V | 6 | |
| | | | W | 7 | |
| Earth terminal | | | ⏚ | | Terminal for grounding. There are two terminals. One should be connected to the earth, and the other should be connected to the motor earth wire. |

* Tighten earth screws with a torque of M4: 0.7 to 0.8 N·m.

**Wiring Procedure**

1 Connect the power supply and motor to Connector XA and Connector XB.

2 Connect the wired connector to the driver.

Insert the connector securely until it is locked.

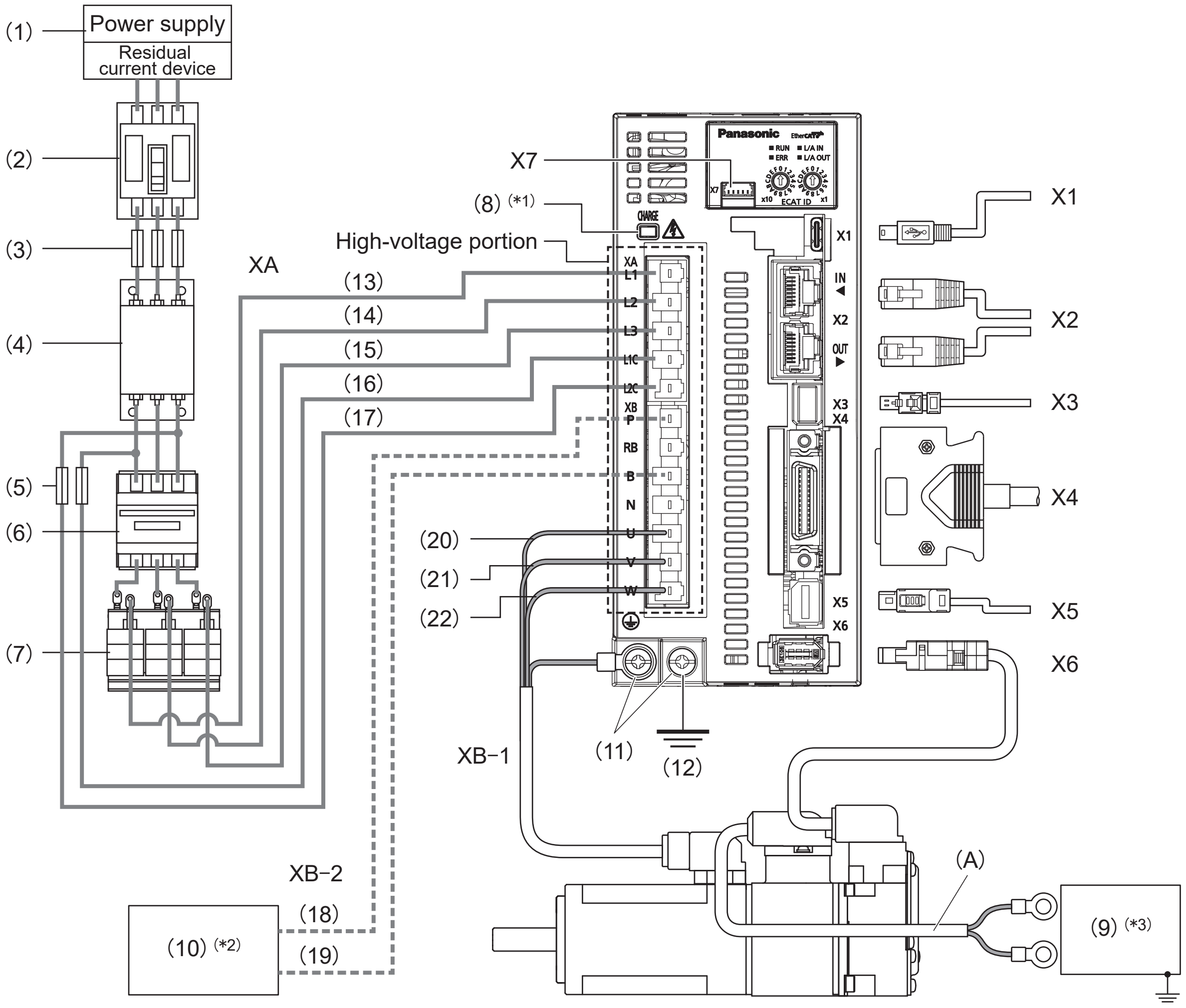
**— Precautions —**

- Wiring should be performed by a qualified electrician.
- In order to prevent electric shocks, do not connect to a power source until the wiring is complete.
- The power connectors (XA and XB) conduct high voltages and carry a risk of electric shock.

**Notes**

- When carrying out wiring work, check *“3.2.1.3 Wiring the Driver XA, XB Connectors”* for the wiring method of the XA and XB power connectors and *“3.2.1.4 Motor Connector Specifications”* for the specifications of the motor connector.

### 3.2.1.2.2 Example Connection for Entire Unit



*1 **Do not move, wire, or inspect the unit when the light is lit. There is a danger of electric shock.**

*2
- **Wire P must be connected to regenerative resistor (18) and wire B to regenerative resistor (19) when connecting to a regenerative resistor (sold separately).**
- **Be sure to install external protection such as a thermal fuse when using an external regenerative resistor.**

- **Each regenerative resistor (sold separately) has a built-in thermal fuse and thermal protector. An activated thermal fuse cannot be restored.**
- **Install the regenerative resistor on nonflammable materials such as metal.**

*3 **X1 to X7 are secondary circuits and must be insulated from the 24 V DC power supply for brakes (9). Do not connect to the same power supply.**

### Parts and wiring, etc.

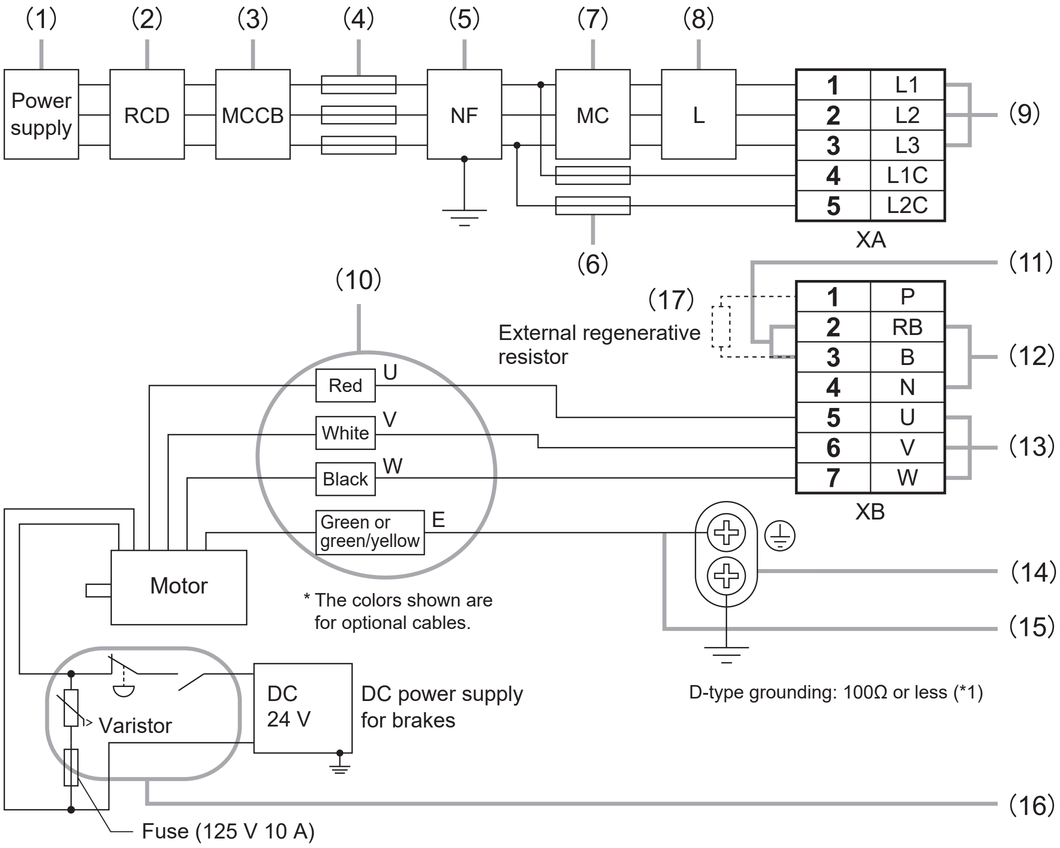
| | | | |
|---|---|---|---|
| (1) | Power supply and residual current device (RCD) | (12) | D-type ground (earth) |
| (2) | Molded-case circuit-breaker (MCCB) | (13) | Main power supply input L1 (1-pin) |
| (3) | Main circuit power supply input line fuse | (14) | Main power supply input L2 (2-pin) |
| (4) | Noise filter (NF) | (15) | Main power supply input L3 (3-pin) |
| (5) | Control circuit power supply input line fuse | (16) | Control power input L1C (4-pin) |
| (6) | Electromagnetic contactor (MC) | (17) | Control power input L2C (5-pin) |
| (7) | Reactor (L) | (18) | Wiring P to the regenerative resistor (1-pin) |
| (8) | Charge lamp (red LED) | (19) | Wiring B to the regenerative resistor (3-pin) |
| (9) | DC power supply for brakes 24 V DC | (20) | U-phase (5-pin, red) (*1) |
| (10) | Regenerative resistor (sold separately) | (21) | V-phase (6-pin, white) (*1) |
| (11) | Earth terminal | (22) | W-phase (7-pin, black) (*1) |

*1 Colors in ( ) are for optional cables.

### Connection points for connectors

| | | | |
|---|---|---|---|
| X1 | Connection to computer | X6 | Connection to encoder |
| X2 | Connection with host device (EtherCAT communication) | X7 | Connection to external monitor |
| X3 | Connection to safety controller | XA | Connection to input power |
| X4 | Parallel I/O connection | XB | 1 Connection to motor driving phase and earth<br>2 External regenerative resistor connection |
| X5 | Connection to external scale | (A) | Connection to DC brake power supply |

### 3.2.1.2.3 Key Points on Wiring



*1 For suitable power cables, see *"1.8.2.3 Electric Wires"* .

1 Check the nameplate of the driver for power specifications.

2 Install a residual current device. Use a residual current device with high-frequency countermeasures "for inverters".

3 Install a molded-case circuit-breaker (MCCB).

4 Connect fuses on the main circuit power supply input. See *"1.8.2.13 Installing Short Protection Elements"* when selecting fuse rated currents.

5 Install a noise filter. When using a single phase power supply, always connect to terminals L1 and L3.

6 Connect fuses on the control circuit power supply input line. See *"1.8.2.13 Installing Short Protection Elements"* when selecting fuse rated currents.

7 Install the coil surge absorber recommended by the manufacturer to the coil of the electromagnetic contactor.

Do not start or stop the motor with the electromagnetic contactor.

8 Install an AC reactor.

9 Connect L1 and L1C, and L3 and L2C for single phase use (100 V and 200 V), and do not use L2.

10 Match the colors of the motor lead wires to those of the corresponding motor output terminals (U, V, W).

11 Normally, do not remove the short wire between RB and B. Remove only when using an external regenerative resistor.

12 Do not connect anything to "N" and "RB".

13 Avoid shorting and earth faults. Do not connect to the main power supply.

14 Ground. To prevent electric shock, be sure to connect the earth terminal (⏚) of the driver and the earth (earth plate) of the control panel. Do not make multiple connections to one earth terminal (⏚). Two earth terminals are provided.

15 Do not connect earth wires to insertion slots for other wires and do not allow them touch.

16 Construct a duplex brake control circuit so that the brake can also be activated by an external emergency stop signal. The holding brake has no polarity.

For holding brake power supply capacity and use, see *“3.3.1 Internal Brake”* .

Install a varistor. Connect a 10 A fuse in series with the varistor.

17 If connecting an external regenerative resistor, the wiring shown with dotted lines is required.

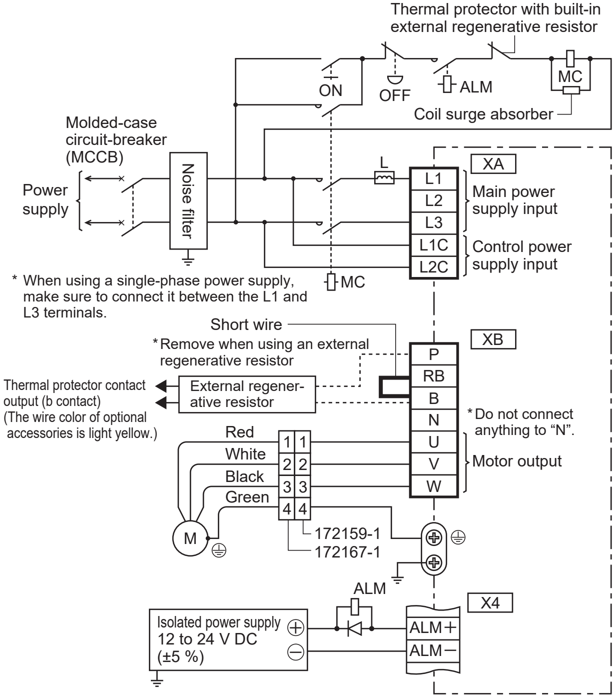
### 3.2.1.2.4 Wiring Figure

**— Precautions —**

- Configure the circuit so that the main power supply will shut off when an alarm occurs.

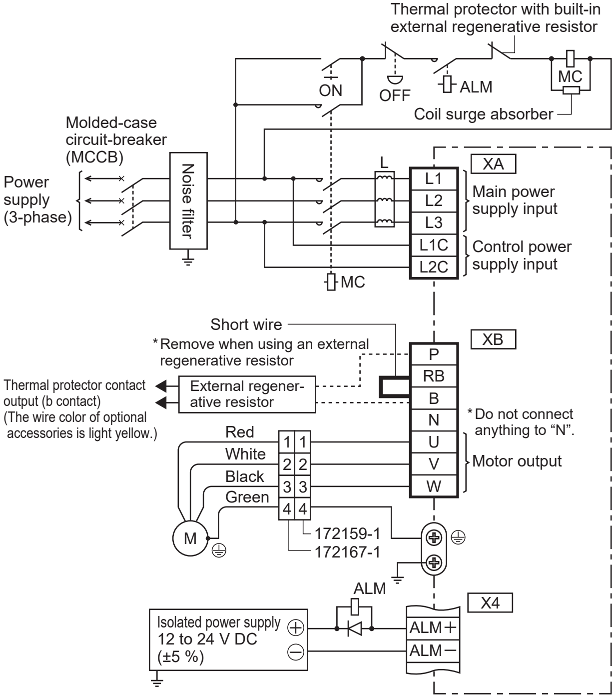
### Single phase 100 V or 200 V

- Lead wire-type motor



### 3-phase 200 V

- Lead wire-type motor



**Notes**

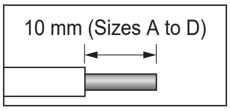
- The regenerative resistor is built into sizes C and D.
  Sizes C and D can also connect with an external regenerative resistor.
  If connecting, apply the wiring shown with dotted lines.

### 3.2.1.3 Wiring the Driver XA, XB Connectors

Follow the procedures below to wire the power supply and motor to connectors XA and XB.

**<< Procedure >>**

1. Strip the wires for use.



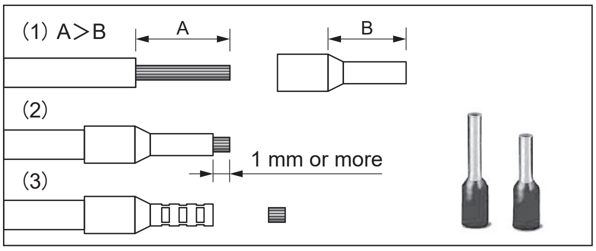
**— Precautions —**

- Be careful not to damage or cut the core wire when stripping the wire.

For single wires, refer to the dimensions in the figure above.

For stranded wires, be sure to use terminals. Examples given for reference below.

**(Example) AI Series terminals with insulating sleeves made by Phoenix Contact**



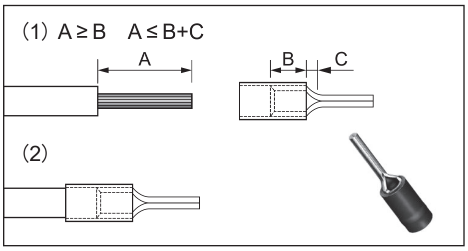
1 Peel off the sheath so that the conductor portion of the wire protrudes from the tip of the terminal (It should protrude 1 mm or more from the terminal.).

2 Insert the wire into the terminal and crimp it with an appropriate crimping tool.

Part No. of the crimping tool: CRIMPFOX U-D66 (1204436) made by Phoenix Contact

3 After crimping, cut off the wire conductor portion protruding from the terminal (The allowable protruding length after cutting should be 0 to 0.5 mm.).

**(Example) VTUB Series vinyl-insulated terminal made by J.S.T. Mfg. Co., Ltd.**



1 Peel off the sheath of the wire conductor portion to the length equal to that of the sheath on the terminal.

2 Insert the wire into the terminal and crimp it with an appropriate crimping tool.

Part No. of the crimping tool: YNT-1614 made by J.S.T. Mfg. Co., Ltd.

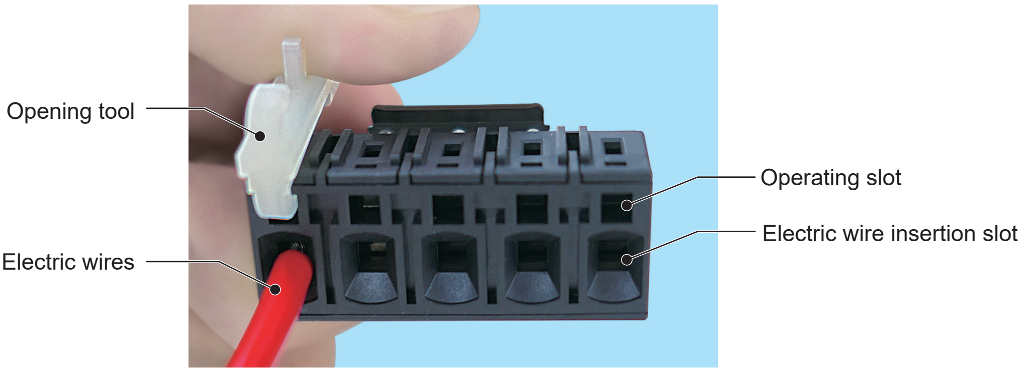
- When peeling off the sheath of the wire, take care not to damage other portions.
- If the conductors of the wire stick out from the insulation cover or protrude excessively from the tip of the terminal, accidents such as electric shocks or fires caused by short circuits may result. When crimping the terminal, carefully check the status of the terminal and wire.

The specifications for adaptive wires for connectors and recommended terminals are shown below.

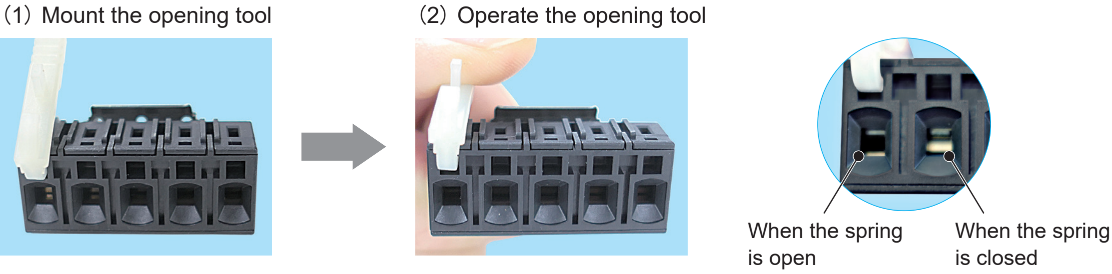
| | | Sizes A to C (100 V/200 V) | Size D (200 V) |
|---|---|---|---|
| Compatible wires | Conductor size | AWG18 to 14 | |
| | Sheath outline | Φ2.1 to 3.8 mm | |
| Recommended terminals | Conductor size | AWG18 | |
| | Terminal model number | AI0.75-8GY<br>(Phoenix Contact ) | |

**2.** Insert the wire into the connector.

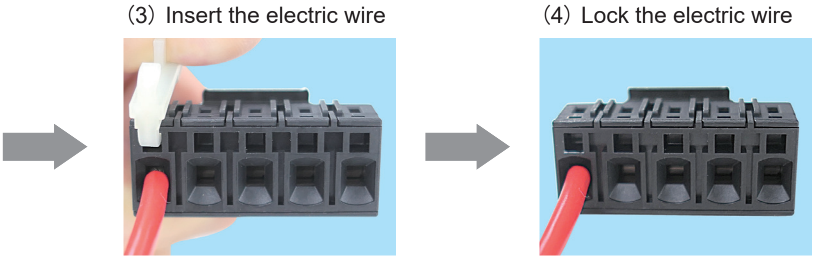
### Connector external appearance



### Insertion procedure


(1) Mount the opening tool

(2) Operate the opening tool


(3) Insert the electric wire

(4) Lock the electric wire

1 Insert the opening tool through the operating slot and attach it to the connector.

2 Push the opening tool down to open the spring.

*The wire can be removed by pressing down on the spring in the same manner as the insertion operation.

3 While holding the opening tool down, insert the wire straight into the wire insertion hole.

*Make sure that the entire strand section that has been peeled is inserted into the spring opening.

4 Release the opening tool and lock the wire. Gently pull on the wires to make sure they are securely connected. Make sure that the wire coating is not pinched by the spring. Remove the opening tool once the wiring has been completed.

**— Precautions —**

- Remove the connector from the driver before making the connection.

- Insert only one wire into each wire insertion hole of the connector.
- Keep the opening tool for the next time you may need to use it.
- Since the strip length of the wire depends on the type of wire, decide the optimum strip length according to the processing condition.

#### 3.2.1.4 Motor Connector Specifications

The encoding connector, brake connector, and motor connector specifications are indicated below.

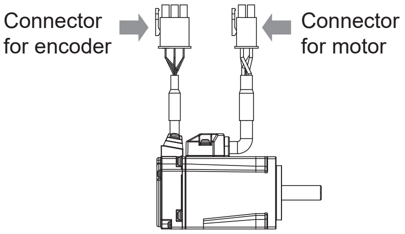
**— Precautions —**

- Do not connect anything to NC.

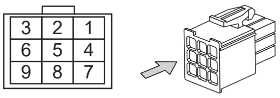
### ■ <MHMG> lead wire type motor

Connector: Made by Tyco Electronics Japan G.K. (the figure below shows a connector on the motor side)

**MHMG 50 W and 100 W (□40)**

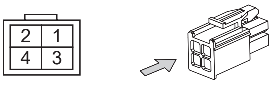


〈Connector for encoder〉

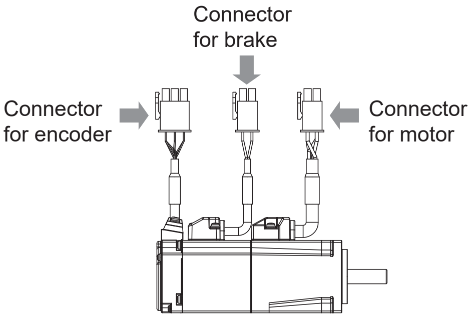


Plug: 172169-1 (made by TE)
Pin: 770835-1 (made by TE)

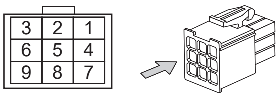
〈Connector for motor〉



Plug: 172167-1 (made by TE)
Pin: 170360-1 (made by TE)

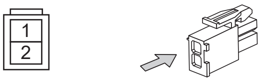


〈Connector for encoder〉



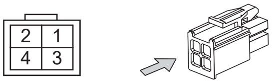
Plug: 172169-1 (made by TE)
Pin: 770835-1 (made by TE)

〈Connector for brake〉



Plug: 172165-1 (made by TE)
Pin: 170360-1 (made by TE)

〈Connector for motor〉



Plug: 172167-1 (made by TE)
Pin: 170360-1 (made by TE)

Connector for encoder

| Pin No. | Purpose |
|---|---|
| 1 | BAT+ |
| 2 | BAT- |
| 3 | FG (shield) |
| 4 | PS |
| 5 | $\overline{\text{PS}}$ |
| 6 | NC |
| 7 | E5V |
| 8 | E0V |
| 9 | NC |

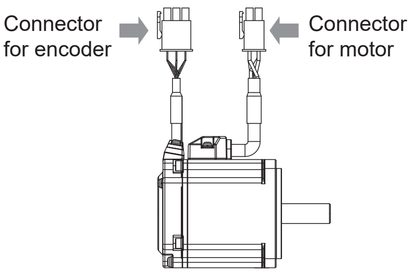
Connector for brake

| Pin No. | Purpose |
|---|---|
| 1 | Brake |
| 2 | Brake |

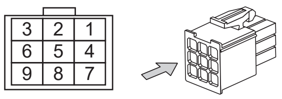
Connector for motor

| Pin No. | Purpose |
|---|---|
| 1 | U-phase |
| 2 | V-phase |
| 3 | W-phase |
| 4 | Earth |

## MHMG 200 W and 400 W (□60)

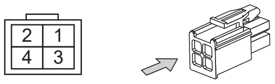


〈Connector for encoder〉

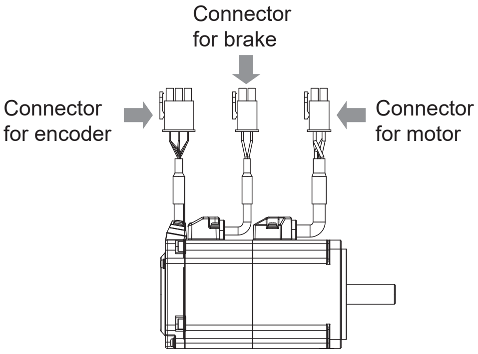


Plug: 172169-1 (made by TE)
Pin: 770835-1 (made by TE)

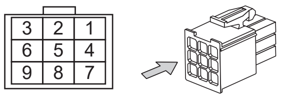
〈Connector for motor〉



Plug: 172167-1 (made by TE)
Pin: 170360-1 (made by TE)

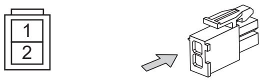


〈Connector for encoder〉



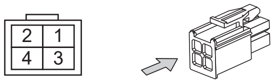
Plug: 172169-1 (made by TE)
Pin: 770835-1 (made by TE)

〈Connector for brake〉



Plug: 172165-1 (made by TE)
Pin: 170360-1 (made by TE)

〈Connector for motor〉



Plug: 172167-1 (made by TE)
Pin: 170360-1 (made by TE)

Connector for encoder

| Pin No. | Purpose |
|---|---|
| 1 | BAT+ |
| 2 | BAT- |
| 3 | FG (shield) |
| 4 | PS |
| 5 | $\overline{\text{PS}}$ |
| 6 | NC |
| 7 | E5V |
| 8 | E0V |
| 9 | NC |

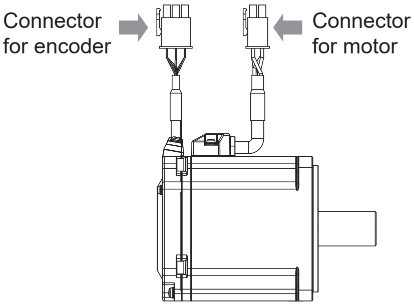
Connector for brake

| Pin No. | Purpose |
|---|---|
| 1 | Brake |
| 2 | Brake |

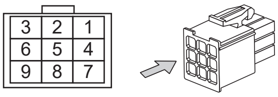
Connector for motor

| Pin No. | Purpose |
|---|---|
| 1 | U-phase |
| 2 | V-phase |
| 3 | W-phase |
| 4 | Earth |

## MHMG 750 W and 1 kW (□80)

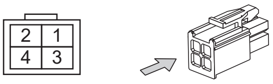


〈Connector for encoder〉

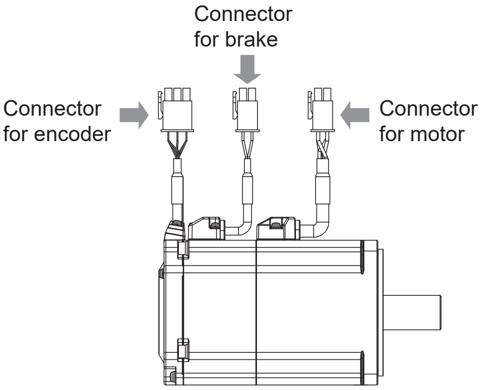


Plug: 172169-1 (made by TE)
Pin: 770835-1 (made by TE)

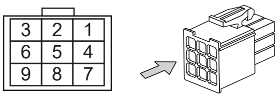
〈Connector for motor〉



Plug: 172167-1 (made by TE)
Pin: 170360-1 (made by TE)

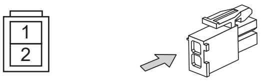


〈Connector for encoder〉



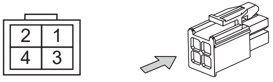
Plug: 172169-1 (made by TE)
Pin: 770835-1 (made by TE)

〈Connector for brake〉



Plug: 172165-1 (made by TE)
Pin: 170360-1 (made by TE)

〈Connector for motor〉



Plug: 172167-1 (made by TE)
Pin: 170360-1 (made by TE)

Connector for encoder

| Pin No. | Purpose |
|---|---|
| 1 | BAT+ |
| 2 | BAT- |
| 3 | FG (shield) |
| 4 | PS |
| 5 | $\overline{\text{PS}}$ |
| 6 | NC |
| 7 | E5V |
| 8 | E0V |
| 9 | NC |

Connector for brake

| Pin No. | Purpose |
|---|---|
| 1 | Brake |
| 2 | Brake |

Connector for motor

| Pin No. | Purpose |
|---|---|
| 1 | U-phase |
| 2 | V-phase |
| 3 | W-phase |
| 4 | Earth |

### 3.2.2 Wiring to Connector X1 (Connecting to Computer)

Connecting to a PC or host device via USB allows for parameter setting/changing, control status monitoring, error status/history reference, parameter saving/loading, and other operations.

The driver uses USB Type-C connectors. Use a commercially available USB Type-C cable.

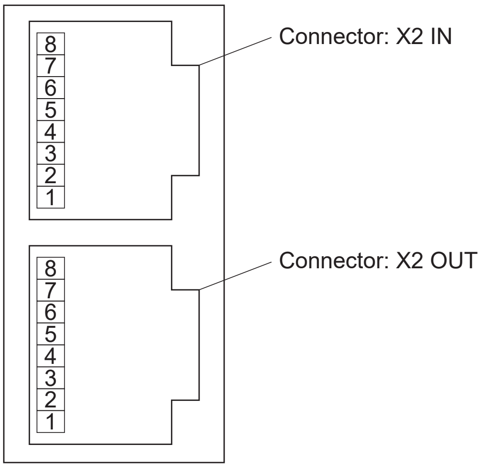
## 3.2.3 Wiring to Connector X2 (Host Device Connection)

### 3.2.3.1 Connector Specifications

Connect an EtherCAT communication cable to connector X2 in order to connect to the host device.

This connector is an RJ45 connector used with EtherCAT and consists of an input X2 IN Connector and an output X2 OUT Connector.

**Pinout diagram**



Specifications for each connector shown below.

[X2 IN] and [X2 OUT] connectors

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| Transmission/Reception + | TX/RX+ | 1 | Connect to communication partner 1-pin |
| Transmission/Reception - | TX/RX- | 2 | Connect to communication partner 2-pin |
| Reception/Transmission + | RX/TX+ | 3 | Connect to communication partner 3-pin |
| NC | — | 4 | Connect to communication partner 4-pin |
| NC | — | 5 | Connect to communication partner 5-pin |
| Reception/Transmission - | RX/TX- | 6 | Connect to communication partner 6-pin |
| NC | — | 7 | Connect to communication partner 7-pin |
| NC | — | 8 | Connect to communication partner 8-pin |
| Frame ground | FG | Shell | Connect to the cable shield. |

Be sure to use industrial 2P4C or 4P8C shielded twisted pair (STP) Ethernet cables compatible with TIA/EIA-568 CAT5e or higher.

For details, see ETG (EtherCAT Technology Group) specifications.

### 3.2.3.2 Key Points on Wiring

- Be sure to use shielded twisted pair cables (STP) compatible with CAT5e or higher.
- If both ends of the shield are not grounded, EMC characteristics will degrade.

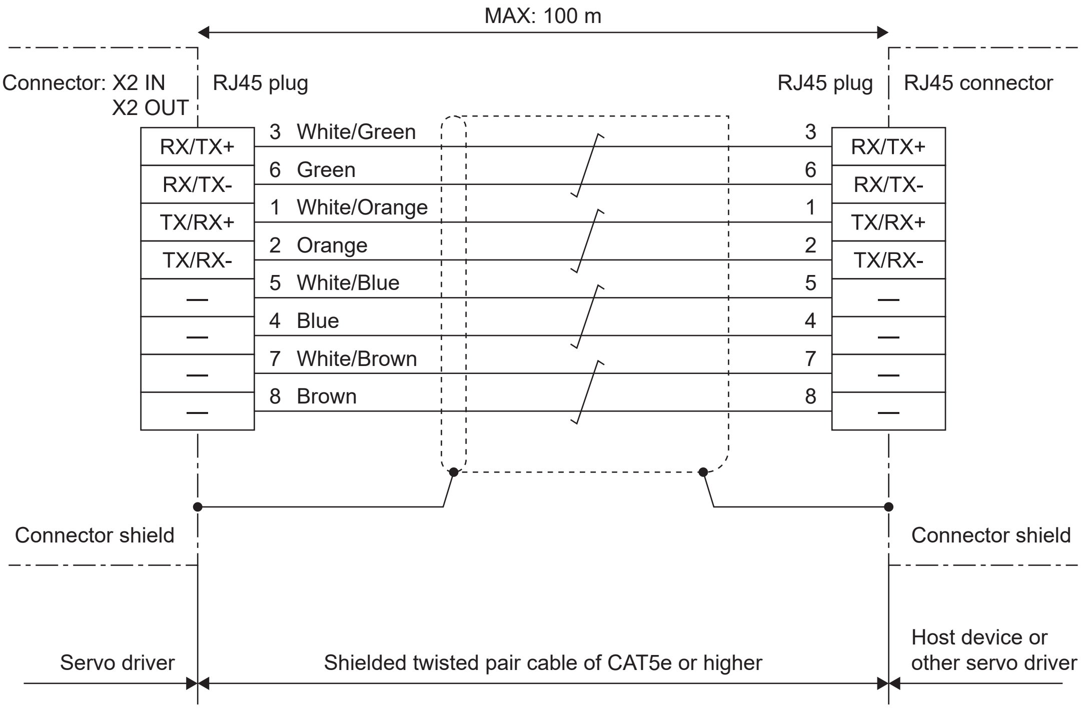
  When attaching the connector plug to each end of the cables, ensure that the shielded wire of the cable is connected to the metal shell of the plug.
- For lead wire colors and matching connector terminals, follow TIA/EIA-568B (see *“3.2.3.3 Wiring Example”* ).

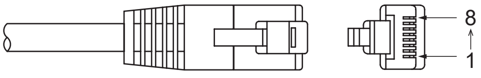
  The two pairs of pins 1-2 and 3-6 are for signal wire. Make sure you also wire connectors for the two unused 4-5 and 7-8 pin pairs.
- Communication cable length should meet both of the below conditions for use.
  - Length of each node: Max. 100 m
- Cable specifications such as bending characteristics, temperature ranges, and covering materials will vary by manufacturer.

  Select a cable that meets the usage conditions at your company.

  Also select a movable cable that meets the usage conditions at your company.

### 3.2.3.3 Wiring Example





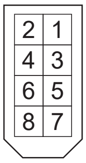
RJ45 plug pin

## 3.2.4 Wiring to Connector X3 (Connecting to the Safety Function Connector)

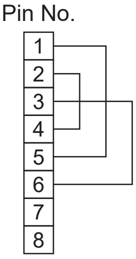
### 3.2.4.1 Connector Specifications

- This is a connector that is compatible with Functional Safety (Safety) specifications, and supports both the multi-function type and application specialized type.
- A safety bypass plug is connected as standard, and set to not use the safety function. If not using the safety function, do not remove the safety bypass plug.
- When using the safety function, remove the safety bypass plug and connect to the host device. For details on the safety functions, see *“9 Safety Function”* .

**Pinout diagram**



**Safety bypass plug supplied with driver (internal wiring)**



This is the wiring for when no safety circuit is constructed.

Do not connect in this way when using safety functions.

| Name | Symbol | Con-nector pin no. | Description |
|---|---|---|---|
| — | — | 1 | This terminal is for the safety bypass, so do not connect anything other than the safety bypass plug. |
| | — | 2 | |
| Safety input 1 | SF1- | 3 | ● Input 1 for operating the STO function. This input interrupts the power transistor upper arm driving signal.<br>● Make sure that it is connected so that the input circuit photocoupler turns OFF when the STO function is activated. |
| | SF1+ | 4 | |
| Safety input 2 | SF2- | 5 | ● Input 2 for operating the STO function. This input interrupts the power transistor lower arm driving signal.<br>● Make sure that it is connected so that the input circuit photocoupler turns OFF when the STO function is activated. |
| | SF2+ | 6 | |
| EDM output | EDM- | 7 | This is a monitoring output for monitoring safety function failures.<br>Do not use this monitor output when using the SSU function. |
| | EDM+ | 8 | |
| Frame ground | FG | Shell | Connected to the earth terminal inside the servo driver. |

For information on safety connectors, see *“12.4.8.6 Connector Kit for Safety”* .

In order to achieve the safety levels SIL3 and PL e, EDM output or SSU function is needed for STO function diagnosis (maximum diagnosis interval is 3 months).

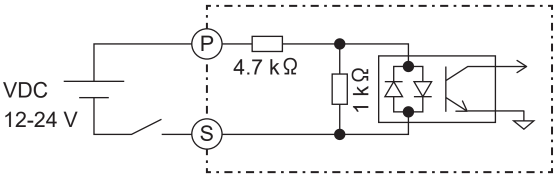
Safety levels are SIL2 and PL d when no STO function diagnosis with EDM output or the SSU function is performed.

For details on diagnostics via the STO function, see *“9.1.4 STO Function Diagnostics”* .

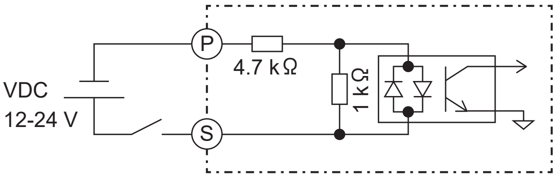
**— Precautions —**

- The unit will stop immediately if the connection cable to the host device or the safety bypass plug is unplugged during operation.

### Safety input signal interface



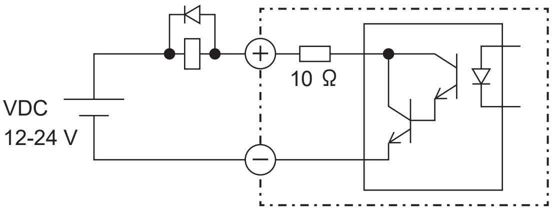
or



P: 4 and 6-pin

S: 3 and 5-pin

### EDM output signal interface



+: 8-pin

-: 7-pin

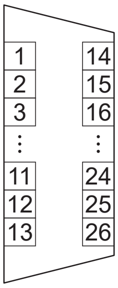
- Note the polarity of the control signal power supply (VDC). The servo driver will be damaged if connected in reversed polarity to that shown in the diagram.
- When the relay is directly driven, install a diode in parallel with the relay and in the direction as shown in the figure.

## 3.2.5 Wiring to Connector X4 (Connecting to I/O)

### 3.2.5.1 Connector Specifications

This is a connector for external input/output (I/O) to which interface cables (26-strand) are connected.

**Pinout diagram**



* (View from the cable side)

Connector (Plug): DF02P026F22A1 (Japan Aviation Electronics Industry, Ltd. or equivalent)

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| General-purpose output 1 | SO1+ | 1 | Assign the desired function using parameters and output the signal for that function.<br>For example, the external brake release signal outputs the alarm. |
| | SO1- | 2 | |
| General-purpose output 3 | SO3+ | 3 | |
| | SO3- | 4 | |
| General-purpose input 1 | SI1 | 5 | ● SI-COM: Shared terminal for general-purpose inputs 1 to 8. Connect to either terminal of the external DC power supply.<br>● SI1 to 8: When the desired function is assigned using parameters, they operate as signal input terminals for that function.<br>For example, general-purpose motor input, or positive direction over-travel inhibit input. |
| General-purpose input common | SI-COM | 6 | |
| General-purpose input 2 | SI2 | 7 | |
| General-purpose input 3 | SI3 | 8 | |
| General-purpose input 4 | SI4 | 9 | |
| General-purpose input 5 | SI5 | 10 | |
| General-purpose input 6 | SI6 | 11 | |
| General-purpose input 7 | SI7 | 12 | |
| General-purpose input 8 | SI8 | 13 | |
| Absolute encoder battery input | BTP-I | 14 | Connect the battery for the absolute encoder. |
| | BTN-I | 15 | |
| Signal ground | GND | 16 | Signal ground. |
| A-phase output/position comparison output 1 | OA+/OCMP1+ | 17 | The following outputs are available using parameter settings.<br>● OA ± and OB ±: Differential output of divided feedback scale signals (A/B-phase).<br>● OCMP1 to 3 ± : Can be used as position comparison output. |
| | OA-/OCMP1- | 18 | |
| B-phase output/position comparison output 2 | OB-/OCMP2- | 19 | |
| | OB+/OCMP2+ | 20 | |
| Position comparison output 3 | OCMP3+ | 21 | |
| | OCMP3- | 22 | |
| Analog input (NC) | AI (NC) | 23 | Analog input with 16-bit resolution. (*1) |
| Signal ground (NC) | GND (NC) | 24 | Signal ground. (*1) |
| General-purpose output 2 | SO2+ | 25 | Assign the desired function using parameters and output the signal for that function. |

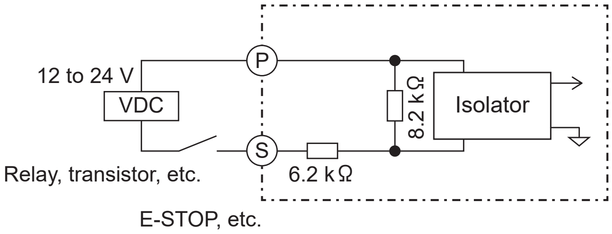
| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| General-purpose output 2 | SO2- | 26 | Assign the desired function using parameters and output the signal for that function. |
| Frame ground | FG | Shell | Connected to the earth terminal inside the servo driver. |

*1 Analog input and signal ground are supported only by the application specialized type. Do not connect to standard type or multi-function type.

### 3.2.5.1.1 Input Signal

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| General-purpose input common | SI-COM | 6 | ● Connect to either the + or - terminal of the external DC power supply (12 to 24 V).<br>● Use a power supply with voltage in the range of 12 V ±5% to 24 V ±5%.<br>● This must be isolated from the primary power supply. Do not connect it to the same power supply.<br>Primary power supply: power supply for motor brake |
| General-purpose input 1 | SI1 | 5 | ● Functions are allocated using parameters.<br>For details, see the “Technical Reference - Functional Specification”. |
| General-purpose input 2 | SI2 | 7 | |
| General-purpose input 3 | SI3 | 8 | |
| General-purpose input 4 | SI4 | 9 | |
| General-purpose input 5 | SI5 | 10 | |
| General-purpose input 6 | SI6 | 11 | |
| General-purpose input 7 | SI7 | 12 | |
| General-purpose input 8 | SI8 | 13 | |

**Signal interface**



P: 6-pin

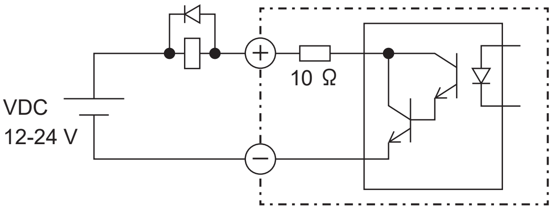
S: 5-, 7-, 8-, 9-, 10-, 11-, 12-, or 13-pin

- The polarity of the control signal power supply (VDC) is random (+ or - polarity).

### 3.2.5.1.2 Output Signal

| Name | Symbol | Connec-tor pin no. | Description |
|---|---|---|---|
| General-purpose output 1 | SO1+<br>SO1- | 1<br>2 | ● Any function can be assigned by using parameters.<br>● The logic of the output pins cannot be changed.<br>● For details on assigning parameters, see *“When changing and using the output signal assignment”* .<br>● For factory standard parameters, see *“Default assignment”* . |
| General-purpose output 2 | SO2+<br>SO2- | 25<br>26 | |
| General-purpose output 3 | SO3+<br>SO3- | 3<br>4 | |

**Signal interface**



+: 1-, 3-, and 25-pin

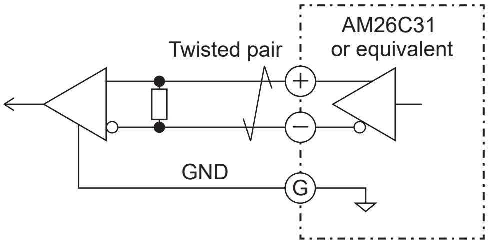
-: 2-, 4-, and 26-pin

- Note the polarity of the control signal power supply (VDC). The servo driver will be damaged if connected in reversed polarity to that shown in the diagram.
- When the relay is directly driven, install a diode in parallel with the relay and in the direction as shown in the figure.

### 3.2.5.1.3 Encoder Output Signal/Position Comparison Output Signal

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| A-phase output / Position comparison output 1 | OA+ / OCMP1+ | 17 | ● Differential output of divided feedback scale signal (A/B phase) (AM26C31 or equivalent).<br>● The division ratio can be set by the parameters.<br>● The ground of the line driver for the output circuit is connected to the signal ground (GND) and is not insulated.<br>● The maximum output frequency is 4 Mpulse/s (after being multiplied by 4).<br>● Pr4.47 “Pulse output selection” can be set to 1 and used as position comparison output.<br>● This differential signal should be received by a line receiver (AM26C32 or equivalent), and a terminating resistor (approx. 330 Ω) should be connected between the line receiver inputs.<br>● Use shielded twisted-pair cables for wiring, and connect the shielded wires to the connector shell. |
| | OA- / OCMP1- | 18 | |
| B-phase output / Position comparison output 2 | OB+ / OCMP2+ | 20 | |
| | OB- / OCMP2- | 19 | |
| Position comparison output 3 | OCMP3+ | 21 | |
| | OCMP3- | 22 | |
| Signal ground | GND | 16 | ● Signal ground.<br>● Always connect the line receiver ground to this terminal. |

**Signal interface**



+: (X4) 17-, 20-, and 21-pin

-: (X4) 18-, 19-, and 22-pin

G: (X4) 16-pin

- Install a terminating resistor (approx. 330 Ω) between line receiver inputs.

#### 3.2.5.1.4 Encoder Backup Battery Input

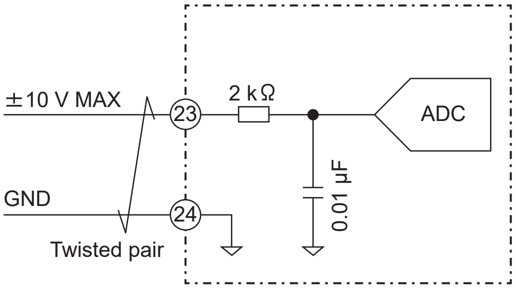
| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| Battery input for absolute encoder | BTP-I | 14 | ● Connect the battery for the absolute encoder. For details, see *“3.2.7.2 Key Points on Wiring”* .<br>BTP-I: Positive+ BTN-I: Negative-<br>● Connect the power for multi-turn data storage to the absolute encoder through BTP-O (3-pin) and BTN-O (4-pin) of encoder connector X6.<br>● Connect the absolute encoder battery using any of the below methods.<br>1 Connect to motor side directly<br>2 Connect to encoder cable<br>3 Connect to this connector |
| | BTN-I | 15 | |

#### 3.2.5.1.5 Analog Input Signal

Analog input and signal ground are supported only by the application specialized type. Do not connect to standard type or multi-function type.

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| Analog input | AIN | 23 | ● Analog input with 16-bit resolution.<br>● The maximum allowable input voltage is ±10 V.<br>● Accuracy of analog input values is not guaranteed.<br>● Assign functions using parameters. For details, see the “Technical Reference - Functional Specification”. |
| Signal ground | GND | 24 | ● Signal ground. |

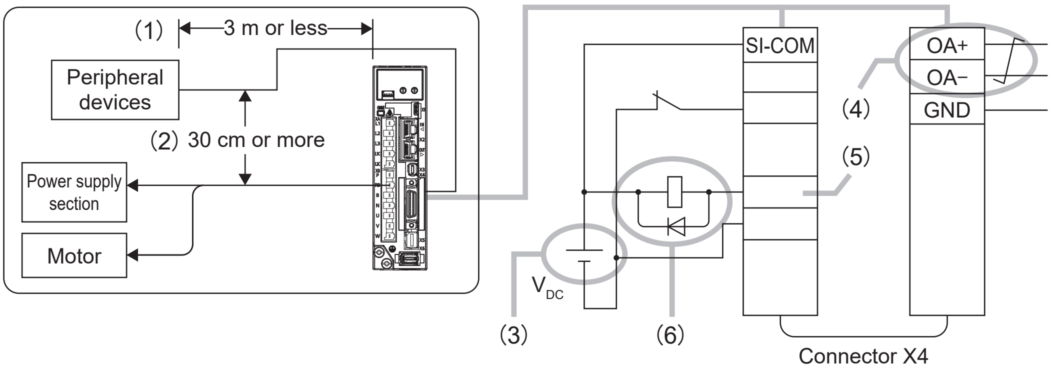
**Signal interface**



#### 3.2.5.1.6 Other

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| Frame ground | FG | Shell | ● Connected to the earth terminal inside the servo driver. |

### 3.2.5.2 Key Points on Wiring



1 Peripheral devices such as sensors should be placed within 3 m.

2 Keep a distance of at least 30 cm between the wiring and the main circuit (connectors XA and XB). Do not pass the wires through the same duct or bundle them together.

3 The control signal power supply (VDC) that connects to SI-COM should be prepared by the customer.

Voltage: 12 to 24 V DC

For the actual wiring, see *“3.2.5.4.1 General-purpose Input Common”* .

Insulation from 24 V DC brake DC power supply is required. Do not connect to the same power supply (See *“1.8.2.12 Control Input/Output Signal Noise Immunity Enhancement”* ).

4 Use shielded twisted pairs of wires for wiring the differential signal output.

5 Do not apply more than 24 V to the control signal output terminals. For the actual wiring, see *“3.2.5.5.1 Control Output Signal”* . In addition, the output current should be less than or equal to the below values.

Rated current: 40 mA

6 When the relay is directly driven by the control output signals, install a diode in parallel with the relay and in the direction as shown in the figure. Failure to install a diode or installing it in the opposite direction may damage the driver.

**Notes**

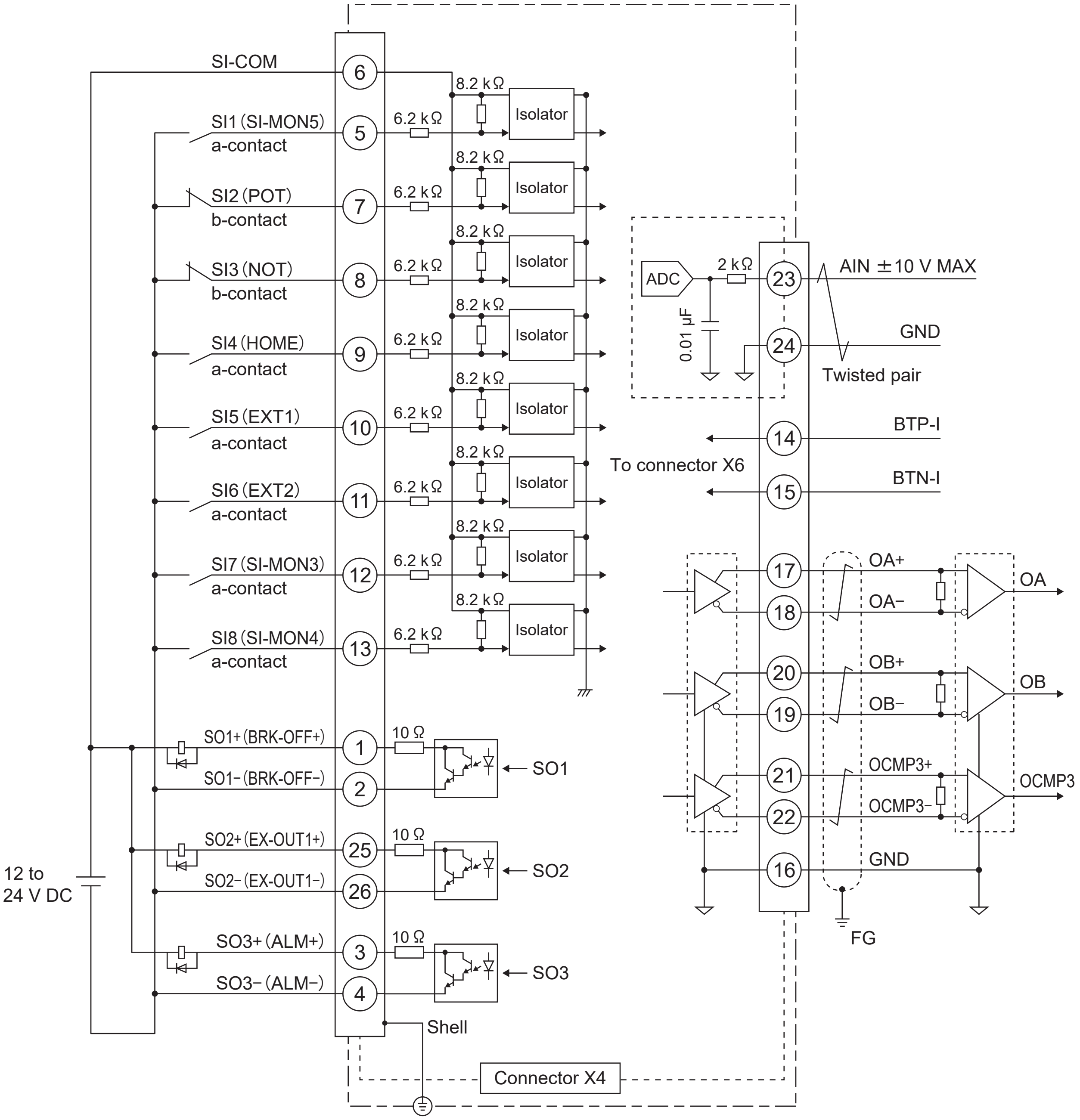
- The connector shell is connected to the earth terminal inside the driver.
- For details of connectors, see *“12.4.8.1 Connector Kit for Interface”* .

**— Precautions —**

- The tightening torque of the screws used for connecting the I/O controller to connector X4 should be 0.2 ±0.05 N·m.

  The driver-side connector may break if you exceed the maximum tightening torque.

### 3.2.5.3 Wiring Example



**Notes**

- The functions of the pins below can be changed depending on the parameters (see *"3.2.5.4.2 Control Input Signal"* - *"When changing and using the input signal assignment"* and *"3.2.5.5.1 Control Output Signal"* - *"When changing and using the output signal assignment"* ).

  Input: 5, 7, 8, 9, 10, 11, 12, 13

  Output: 1, 2, 3, 4, 25, 26

  The functions of the pins in the above diagram are the factory default values.

## 3.2.5.4 Input Signal and Pin No.

How to read the table (applies to both *“3.2.5.4 Input Signal and Pin No.”* and *“3.2.5.5 Output Signals and Pin No.”* )

| | |
|---|---|
| Pin No. | The pin assignment number of the signal in question |
| Symbol | The symbol of the input signal or output signal<br>The EtherCAT communication symbol is shown in parentheses ( )<br>Note that detection conditions for external output signals and EtherCAT communication signals are not the same. |
| Signal name | Signal name |
| Related mode | Related modes symbol<br>P (position control/full-closed control mode), S (velocity control mode), T (torque control mode) |
| Communications monitor | Whether monitoring is possible with the EtherCAT communication object<br>○ Monitoring is possible with objects 4F21h, 4F23h, and 60FDh<br>— Monitoring not possible because no object is assigned |

* Check the operating instructions for the host device for a detailed description and how to handle the input/output signal.

### 3.2.5.4.1 General-purpose Input Common

| Pin No. | Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|---|
| 6 | SI-COM | General-purpose input common | — | — | — | — |

Connect to either the + or - terminal of the external DC power supply (12 to 24 V).

Use a power supply with voltage in the range of 12 V ±5% to 24 V ±5%.

### 3.2.5.4.2 Control Input Signal

Any function can be assigned to control input signals SI1 to SI8.

The logic can also be changed.

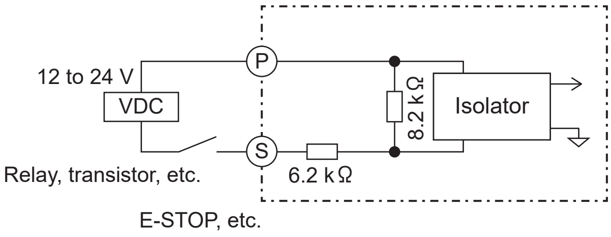
For details on assigning parameters, see *“When changing and using the input signal assignment”* . For factory standard parameters, see *“Default assignment”* .

#### ■ Control input circuit

| Pin No. | Symbol | Signal name |
|---|---|---|
| 5 | SI1 | General-purpose input 1 |
| 7 | SI2 | General-purpose input 2 |
| 8 | SI3 | General-purpose input 3 |
| 9 | SI4 | General-purpose input 4 |
| 10 | SI5 | General-purpose input 5 |
| 11 | SI6 | General-purpose input 6 |
| 12 | SI7 | General-purpose input 7 |
| 13 | SI8 | General-purpose input 8 |

The input signal connects to contacts on switches and relays, or open collector output transistors.

When using contact input, use switches and relays for micro current to avoid contact failure.



### ■ Functions that can be allocated to control inputs

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| E-STOP | Forced alarm input | P | S | T | ○ |

- Generates Err87.0.0 “Forced alarm input protection” .

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| POT | Positive direction over-travel inhibit input | P | S | T | ○ |

- A positive direction over-travel inhibit input.
- The operation when this input is turned ON is set in Pr5.04 “Over-travel inhibit input setup” .
- When using the driver to control, make the connections so that this input is ON when the moving portion of the machine exceeds the range of movement in a positive direction.
- If used as a home position reference trigger in the homing operation, this input signal can be assigned to SI5, SI6, or SI7.
- The signal width should be at least 1 ms when closed and 2 ms when open. Note that these values are not guaranteed values.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| NOT | Negative direction over-travel inhibit input | P | S | T | ○ |

- Negative direction over-travel inhibit input.
- The operation when this input is turned ON is set with Pr5.04 “Over-travel inhibit input setup” .
- When using the driver to control, make the connections so that the input is ON when the range the moving portion of the machine moves in a negative direction exceeds this input signal range.
- If used as a home position reference trigger in the homing operation, this input can be assigned to SI5, SI6, or SI7
- The signal width should be at least 1 ms when closed and 2 ms when open. Note that these values are not guaranteed values.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| HOME | Near home input | P | S | T | ○ |

- When using the near home sensor during the homing operation, input the sensor signal.
- If used as a home position reference trigger in the homing operation, this input can be assigned to SI5, SI6, or SI7.
- The signal width should be at least 1 ms when closed and 2 ms when open. Note that these values are not guaranteed values.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| RET | Retracting operation input | P | S | T | ○ |

- The retracting operation is performed when the conditions set in Pr6.85 “Retracting operation condition setting” are met.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| EXT1 | External latch input 1 | P | S | T | ○ |

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| EXT2 | External latch input 2 | P | S | T | ○ |

- An external signal input is used as a trigger signal for touch probe and homing operation.
- The signal width should be at least 1 ms when closed and 2 ms when open. Note that these values are not guaranteed values.
- EXT1 and EXT2 can be assigned to any of SI5, SI6, or SI7.

When using positive direction over-travel inhibit input (POT), negative direction over-travel inhibit input (NOT) and near home input (HOME) with the edge method, and when using external latch inputs 1 to 2 (EXT 1 to 2), these inputs can only be assigned to SI5, SI6 and SI7 respectively.

For details of assigning methods and conditions, see *“When changing and using the input signal assignment”* .

Check the operating instructions for the host device for actual position latch via signal input and homing operations using these signals.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| SI-MON1 | General-purpose monitor input 1 | P | S | T | ○ |
| SI-MON2 | General-purpose monitor input 2 | P | S | T | ○ |
| SI-MON3 | General-purpose monitor input 3 | P | S | T | ○ |
| SI-MON4 | General-purpose monitor input 4 | P | S | T | ○ |
| SI-MON5 | General-purpose monitor input 5 | P | S | T | ○ |

- Used as the general-purpose monitor input.
- Turning this input signal ON/OFF has no impact on operation, and can be monitored via Obj.4F21h:00h “Logical input signal” , Obj.4F23h:00h “Logical input signal (expansion portion)” , and Obj.60FDh:00h “Digital inputs” .
- SI-MON1 and EXT1, SI-MON2 and EXT2, and SI-MON5 and E-STOP cannot overlap. Err33.0.0 “Input overlapping assignment error 1 protection” and Err33.1.0 “Input overlapping assignment error 2 protection” are generated when parameters overlap.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| A-CLR | External alarm clear input | P | S | T | ○ |

- Deactivates the alarm state.
- Some alarms cannot be deactivated with this input.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| DB-SEL | Dynamic brake (DB) switching input | P | S | T | ○ |

- Switches the dynamic brake (DB) ON/OFF after stop (when the main power is off).
  Switching is only possible when main power supply off is detected.

**— Precautions —**

- When using the dynamic brake switching input (DB-SEL), Pr6.36 “Dynamic brake operation input setup” must be set to 1, and the dynamic brake (DB) switching input must be set for input selection in all control modes after. When only one or two control modes are set, either Err33.2.0 “Input function number error 1 protection” or Err33.3.0 “Input function number error 2 protection” will occur.

### ■ Default assignment

| Pin name | Pin No. | Supported parameters | Factory default value (*1)<br>(): decimal | Factory default setup state | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Position control | | Velocity control | | Torque control | |
| | | | | Signal name | Logic (*2) | Signal name | Logic (*2) | Signal name | Logic (*2) |
| SI1 | 5 | Pr4.00 | 00323232h<br>(3289650) | SI-MON5 | a-contact | SI-MON5 | a-contact | SI-MON5 | a-contact |

| Pin name | Pin No. | Supported parameters | Factory default value (*1)<br>(): decimal | Factory default setup state | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Position control | | Velocity control | | Torque control | |
| | | | | Signal name | Logic (*2) | Signal name | Logic (*2) | Signal name | Logic (*2) |
| SI2 (*3) | 7 | Pr4.01 | 00818181h<br>(8487297) | POT | b-contact | POT | b-contact | POT | b-contact |
| SI3 (*3) | 8 | Pr4.02 | 00828282h<br>(8553090) | NOT | b-contact | NOT | b-contact | NOT | b-contact |
| SI4 | 9 | Pr4.03 | 00222222h<br>(2236962) | HOME | a-contact | HOME | a-contact | HOME | a-contact |
| SI5 | 10 | Pr4.04 | 00202020h<br>(2105376) | EXT1 | a-contact | EXT1 | a-contact | EXT1 | a-contact |
| SI6 | 11 | Pr4.05 | 00212121h<br>(2171169) | EXT2 | a-contact | EXT2 | a-contact | EXT2 | a-contact |
| SI7 | 12 | Pr4.06 | 00303030h<br>(3158064) | SI-MON3 | a-contact | SI-MON3 | a-contact | SI-MON3 | a-contact |
| SI8 | 13 | Pr4.07 | 00313131h<br>(3223857) | SI-MON4 | a-contact | SI-MON4 | a-contact | SI-MON4 | a-contact |

*1 Factory default values are arranged in the following order, with two hexadecimal digits for each.

00/Torque Control/Velocity Control/Position Control or Full-closed Control (8 hexadecimal digits)

You can also refer to Pr4.00 “SI1 input selection” below or Pr4.10 “SO1 output selection” for specific examples.

*2 “a-contact” and “b-contact” refer to the following states.

a-contact (Normally open: function OFF with no input):

Current in the input circuit is stopped and the isolator is turned OFF, disabling the function (OFF state)

Current flows through the input circuit and the isolator is turned ON, enabling the function (ON state)

b-contact (Normally closed: function ON with no input):

Current in the input circuit is stopped and the isolator is turned OFF, enabling the function (ON state)

Current flows through the input circuit and the isolator is turned ON, disabling the function (OFF state)

*3 POT (SI2) and NOT (SI3) are assigned to the b-contact by default. Therefore, if neither a POT nor NOT signal is input, over-travel inhibit input protection is activated and the motor does not rotate.

Implement one of the following measures.

1 Input POT and NOT signals.

2 Change POT and NOT assignments.

- Change the b-contact setting to a-contact. Or, Cancel POT and NOT assignment.

## ■ When changing and using the input signal assignment

Change the following parameters to change the input signal assignment.

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 00 | C | SI1 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI1 input.<br>This parameter is set using the hexadecimal display standard.<br>After displaying in hexadecimal format, set for each control mode as shown below.<br>00yyyyxxh: Position control/full-closed control<br>00yyxxyyh: Velocity control<br>00xxyyyyh: Torque control<br>Enter the function No. into the “xx” portion.<br>For details on function numbers, see *“Function No. table”* below. Logic can also be set using the function number.<br>(Setting example)<br>To disable this pin, set it to the a-contact of SI-MON1 in position control/full-closed control, to the b-contact of SI-MON2 in velocity control, and to 0000AF2Eh in torque control.<br>Position: 2Eh, Speed: AFh, Torque: 00h |
| 4 | 01 | C | SI2 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI2 input.<br>The setup method is the same as for Pr4.00. |
| 4 | 02 | C | SI3 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI3 input.<br>The setup method is the same as for Pr4.00. |
| 4 | 03 | C | SI4 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI4 input.<br>The setup method is the same as for Pr4.00. |
| 4 | 04 | C | SI5 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI5 input.<br>The setup method is the same as for Pr4.00.<br>This pin has a latch compensation function. |
| 4 | 05 | C | SI6 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI6 input.<br>The setup method is the same as for Pr4.00.<br>This pin has a latch compensation function. |
| 4 | 06 | C | SI7 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI7 input.<br>The setup method is the same as for Pr4.00.<br>This pin has a latch compensation function. |
| 4 | 07 | C | SI8 input selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SI8 input.<br>The setup method is the same as for Pr4.00. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### Function No. table

—: N/A

| Signal name | Symbol | Setup value | |
|---|---|---|---|
| | | a-contact | b-contact |
| Invalid | — | 00h | Cannot be set |
| Positive direction over-travel inhibit input | POT | 01h | 81h |
| Negative direction over-travel inhibit input | NOT | 02h | 82h |
| External alarm clear input | A-CLR | 04h | Cannot be set |

| Signal name | Symbol | Setup value | |
|---|---|---|---|
| | | a-contact | b-contact |
| Forced alarm input | E-STOP | 14h | 94h |
| Dynamic brake (DB) switching input | DB-SEL | 16h | Cannot be set |
| External latch input 1 | EXT1 | 20h | A0h |
| External latch input 2 | EXT2 | 21h | A1h |
| Near home input | HOME | 22h | A2h |
| Retracting operation input | RET | 27h | A7h |
| General-purpose monitor input 1 | SI-MON1 | 2Eh | AEh |
| General-purpose monitor input 2 | SI-MON2 | 2Fh | AFh |
| General-purpose monitor input 3 | SI-MON3 | 30h | B0h |
| General-purpose monitor input 4 | SI-MON4 | 31h | B1h |
| General-purpose monitor input 5 | SI-MON5 | 32h | B2h |

## ■ Control input signal read cycle

The control input signal read cycle is set using the following parameters.

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 15 | C | Control input signal reading setup | 0 to 3 | — | Selects the signal reading cycle for control input.<br>0: 250 μs<br>1: 500 μs<br>2: 1 ms<br>3: 2 ms<br>Excludes POT, NOT, and HOME as home reference triggers, as well as external latch input 1 (EXT1) and external latch input 2 (EXT2). |

*1 For attributes, see *"6.2 Object Dictionary List"* .

## ■ Precautions

1 Input signal assignment

- Do not use setup values other than those listed in the table.
- The same signal cannot be assigned to more than one pin. If you do so anyway, Err33.0.0 "Input overlapping assignment error 1 protection" and Err33.1.0 "Input overlapping assignment error 2 protection" will occur.
- Control input pins set to disabled have no effect on operation.
- Signals used in multiple control modes must be assigned to the same pins and their logics must be matched. If not assigned to the same pin, Err33.0.0 "Input overlapping assignment error 1 protection" or Err33.1.0 "Input overlapping assignment error 2 protection" will occur. If the logic does not match, Err33.2.0 "Input function number error 1 protection" or Err33.3.0 "Input function number error 2 protection" will occur.
- SI-MON1 and EXT1, SI-MON2 and EXT2, and SI-MON5 and E-STOP cannot overlap. Err33.0.0 "Input overlapping assignment error 1 protection" and Err33.1.0 "Input overlapping assignment error 2 protection" are generated when parameters overlap.
- A-CLR can be set only for a-contact. Err33.2.0 "Input function number error 1 protection" or Err33.3.0 "Input function number error 2 protection" will occur if set to b-contact.

- Control mode is forcibly switched inside this product according to its operation status, regardless of commands from the host device. Because this operation also affects input signal assignments, it is generally recommended to assign the same function to each terminal in all modes.

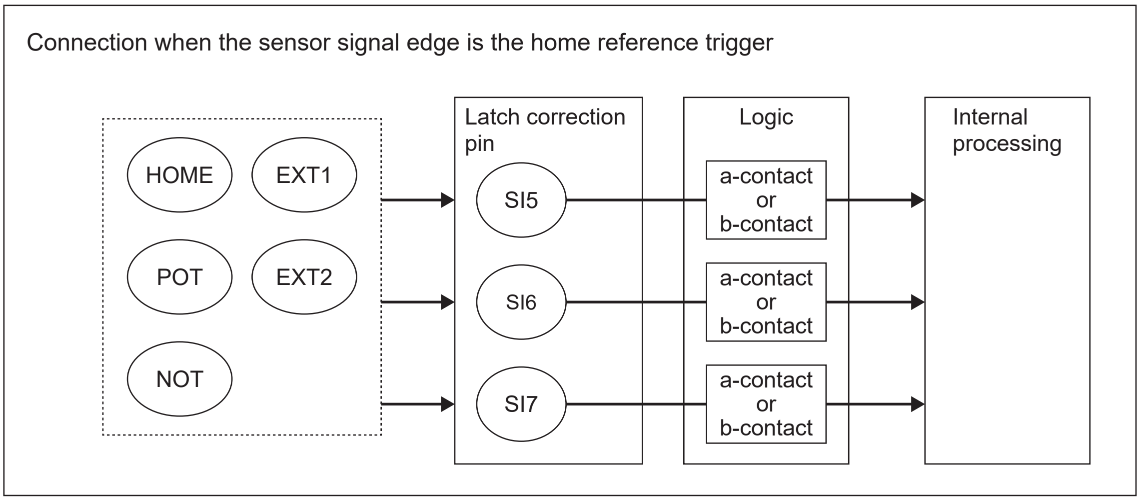
  The conditions for forcibly switching control modes are shown below.

| Operation status if this product | Control mode after forced switching |
|---|---|
| When using Set-up Support Software (PANATERM ver.7) to perform frequency characteristics analysis | ● During position loop characteristics analysis: Position control<br>● During velocity closed-loop characteristics analysis: Velocity control<br>● During torque speed (automatic) analysis: Position control<br>● During torque speed (vertical) analysis: Velocity control<br>● During torque speed (normal) analysis: Torque control |
| During trial run via Set-up Support Software (PANATERM ver.7) | ● Position control |
| Operations with descriptions of "forcible position control" using various deceleration to stop functions ( *"8.12"* to *"8.15"* ) | ● Position control |
| During retracting operations | ● Position control |

- When using the dynamic brake switching input (DB-SEL), settings are required for all control modes after setting Pr6.36 "Dynamic brake operation input setup" = 1. When only one or two control modes are set, either Err33.2.0 "Input function number error 1 protection" or Err33.3.0 "Input function number error 2 protection" will occur. For details, see *"8.15 Deceleration to Stop Function for When Alarm is Triggered"* .
- When using the forced alarm input (E-STOP) or a retracting operation input (RET), settings must be complete for all control modes. When only one or two control modes are set, either Err33.2.0 "Input function number error 1 protection" or Err33.3.0 "Input function number error 2 protection" will occur. For details, see *"8.15 Deceleration to Stop Function for When Alarm is Triggered"* .

2 Latch correction pins (SI5/SI6/SI7)

- When using POT/NOT as the home reference trigger in the homing operation, set Pr5.04 "Over-travel inhibit input setup" to 1 and disable over-travel inhibit input. If Pr5.04 "Over-travel inhibit input setup" is not set to 1, Err38.2.0 "Over-travel inhibit input protection 3" will occur.
- When using the latch correction pins (SI5/SI6/SI7), the same settings are required for all control modes. When only one or two control modes are set, Err33.8.0 "Latch input assignment error protection" will occur.



3 Safety precautions

The over-travel inhibit input (POT, NOT) and the forced alarm input (E-STOP) should normally be set to b-contact, which stops when disconnected.

If setting to a-contact, be sure to confirm that there are no safety issues.

### 3.2.5.4.3 Encoder Backup Power Supply Input

| Pin No. | Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|---|
| 14 | BTP-I | Battery input for absolute encoder | – | – | – | – |
| 15 | BTN-I | | | | | |
| Connect the battery for the absolute encoder.<br>(BTP-I: Positive+ BTN-I: Negative-)<br>For absolute encoder batteries, see *“12.4.9 Battery for Absolute Encoder”* .<br>Connect the power for multi-turn data storage to the absolute encoder through BTP-O (pin 3) and BTN-O (pin 4) of encoder connector X6.<br>Either directly connect the encoder connection cable to the battery, or connect this terminal to the battery.<br>For connection methods other than connecting the battery to this connector, see *“3.2.7.3 Wiring Example”* . | | | | | | |

### 3.2.5.4.4 Analog Input Signal

| Pin No. | Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|---|
| 23 | AIN | Analog input | P | – | – | – |
| 24 | GND | Signal ground | – | – | – | – |
| Analog input with 16-bit resolution.<br>The maximum allowable input voltage is ±10 V.<br>Accuracy of analog input values is not guaranteed.<br>Compatible with only the application specialized type.<br>Do not connect anything to standard types or multi-function types. | | | | | | |

### 3.2.5.5 Output Signals and Pin No.

#### 3.2.5.5.1 Control Output Signal

Any function can be assigned to control output signals SO1 to SO3.

The logic of the output pins cannot be changed.

For details on assigning parameters, see *“When changing and using the output signal assignment”* . For factory standard parameters, see *“Default assignment”* .

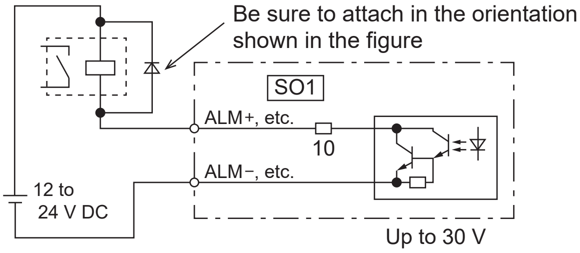
#### ■ Control output circuit

| Pin No. | Symbol | Signal name |
|---|---|---|
| 1 | SO1+ | General-purpose output 1 |
| 2 | SO1- | |
| 25 | SO2+ | General-purpose output 2 |
| 26 | SO2- | |
| 3 | SO3+ | General-purpose output 3 |
| 4 | SO3- | |

The output circuit is composed of open collector Darlington connection transistor outputs.

Because the output transistors use Darlington connections, the voltage $V_{ce}$ (sat) is approx. 1 V between the collector and emitter when the transistor is ON. Note that normal TTL ICs cannot satisfy VIL and cannot be directly connected.

The current to be passed through each output must not exceed a rated current of 40 mA.


Be sure to attach in the orientation shown in the figure

#### ■ Functions that can be allocated to control outputs

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| ALM (Alarm) | Servo alarm output | P | S | T | ○ |
| • This output signal shows the alarm generation status.<br>The output transistor turns ON during normal circumstances, and OFF when an alarm is triggered. | | | | | |

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| S-RDY | Servo-ready output | P | S | T | ○ |
| • This output signal shows that the motor is ready to be energized.<br>The output transistor will turn ON when all of the below conditions are satisfied.<br>- Control/main power supply is established<br>- Alarm not activated.<br>- EtherCAT communication established | | | | | |

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| BRK-OFF | External brake release signal | P | S | T | ○ |

- Outputs the timing signal which activates the electromagnetic brake of the motor.
  The output transistor will turn ON when the electromagnetic brake releases.
- When switching control mode during operation, the signal must be assigned to all control modes.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| set brake | set brake output | P | S | T | × |

- Outputs the output signal set in Obj.60FEh: “Digital outputs” :bit 0.
  1: Turns output transistor OFF (Brake is engaged).
  0: Turns output transistor ON.
- The output transistor turns OFF (brake on) if EtherCAT communication is not established.

**Notes**

- The EtherCAT communication state and the transistor state for each object (parameter) setup will change as follows according to the communication state.

  There are four communication states.

  When reset: When communication is not established after reset

  Communication established: When the ESM state is PreOP or higher

  When communication is interrupted: When RxPDO communication becomes impossible (ESM state changes from OP to something other than OP), or when SDO communication becomes impossible (ESM state changes to Init)

  When communication is re-established: When Obj.60FEh: “Digital outputs” : 01h or Obj.60FEh: “Digital outputs” : 02h is normally written

| Symbol | Pr7.24 “Communication function extended setup 3” Setup value | Obj.60FEh: “Digital outputs” Setup value | | Output transistor state | | | |
|---|---|---|---|---|---|---|---|
| | | 01h “Physical outputs” | 02h “Bit mask” | When reset | Communication established | When communication is interrupted | Communication re-established |
| set brake | — | 0 | 0 | set brake = 1 (brake on) | set brake = 1 (brake on) | set brake = 1 (brake on) | set brake = 1 (brake on) |
| | | 1 | | | | | |
| | | 0 | 1 | set brake = 1 (brake on) | set brake = 0 | set brake = 1 (brake on) | set brake = 0 |
| | | 1 | | | set brake = 1 (brake on) | | set brake = 1 (brake on) |

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| INP | Positioning complete | P | — | — | ○ |

- Outputs the positioning complete signal.
  Turns the output transistor ON when positioning is complete.
  For details, see *“7.3.4 Positioning Complete Output (INP/INP2) Function”* .

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| AT-SPEED | Speed arrival output | — | S | T | ○ |

- Outputs the speed arrival signal.
  Turns ON the output transistor when the speed has been reached.
  For details, see *“7.4.4 Speed Arrival Output (AT-SPEED)”* .

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| TLC | Torque limit signal output | P | S | T | ○ |

- Outputs the torque limit signal.
  Turns ON the output transistor when torque is limited.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| ZSP | Zero-speed detection signal | P | S | T | ○ |

- Outputs the zero-speed detection signal.
  Turns ON the output transistor upon detection of zero-speed.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| V-COIN | Velocity coincidence output | – | S | T | ○ |

- Outputs the velocity coincidence signal.
  Turns ON the output transistor upon coincidence of velocity.
  For details, see *“7.4.5 Velocity Coincidence Output (V-COIN)”* .

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| INP2 | Positioning complete 2 | P | – | – | ○ |

- Outputs the positioning complete signal 2.
  Turns the output transistor ON when positioning is complete 2.
  For details, see *“7.3.4 Positioning Complete Output (INP/INP2) Function”* .

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| WARN1 | Warning output 1 | P | S | T | ○ |

- Outputs the warning output signal set in Pr4.40 “Selection of alarm output 1” .
  Turns ON the output transistor when the selected warning is triggered.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| WARN2 | Warning output 2 | P | S | T | ○ |

- Outputs the warning output signal set in Pr4.41 “Selection of alarm output 2” .
  Turns ON the output transistor when the selected warning is triggered.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| P-CMD | Position command on/off signal | P | – | – | ○ |

- Outputs the position command on/off signal.
  Turns ON the output transistor when the position command (pre-filter) is something other than 0 (with position command).

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| V-LIMIT | Output during velocity limit | – | – | T | ○ |

- Outputs the velocity limit signal during torque control.
  Turns ON the output transistor when velocity is limited.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| ALM-ATB | Alarm clear attribute output | P | S | T | ○ |

- The signal is output if an alarm has occurred and if it can be cleared.
  Turns ON the output transistor when the relevant alarm is triggered.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| V-CMD | Speed command on/off output | – | S | – | ○ |

- Outputs the speed command on/off signal during velocity control.
  Turns ON the output transistor when the speed command (before filter) is 30 r/min or higher (with speed command).

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| EX-OUT1 | General-purpose output 1 | P | S | T | ○ |

- Outputs the output signal set in Obj.60FEh: “Digital outputs” :bit 16.
  0: Output transistor is OFF
  1: Output transistor is ON
  The output transistor turns OFF if EtherCAT communication is not established.

**Notes**

- The EtherCAT communication state and the transistor state for each object (parameter) setup will change as below according to the communication state. There are four communication states.
  When reset: When communication is not established after reset
  Communication established: When the ESM state is PreOP or higher
  When communication is interrupted: When RxPDO communication becomes impossible (ESM state changes from OP to something other than OP), or when SDO communication becomes impossible (ESM state changes to Init)
  When communication is re-established: When Obj.60FEh: “Digital outputs” : 01h or Obj.60FEh: “Digital outputs” : 02h is normally written

| Symbol | Pr7.24 “Communication function extended setup 3” Setup value | Obj.60FEh: “Digital outputs” Setup value | | Output transistor state | | | |
|---|---|---|---|---|---|---|---|
| | | 01h “Physical outputs” | 02h “Bit mask” | When reset | Communication established | When communication is interrupted | Communication re-established |
| EX-OUT1 | bit 0 = 0<br>(Retained) | 0 | 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0<br>(Retained) | EX-OUT1 = 0 |
| | | 1 | | | EX-OUT1 = 1 | EX-OUT1 = 1<br>(Retained) | EX-OUT1 = 1 |
| | bit 0 = 1<br>(Initialized) | 0 | 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | EX-OUT1 = 1 | | EX-OUT1 = 1 |

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| SRV-ST | Servo-on status output | P | S | T | ○ |

- Turns ON the output transistor during servo-on.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| CMP-OUT | Position comparison output | P | S | T | ○ |

- The output transistor is turned ON or OFF when the actual position passes the position set by the parameter.

| Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|
| V-DIAG | Deterioration diagnosis velocity output | P | S | T | ○ |
| • Output transistor turns ON when the motor speed is within the range of Pr5.75 “Deterioration diagnosis velocity setting” - Pr4.35 “Speed coincidence range” .<br>• There is a hysteresis of 10 r/min in the coincidence determination of deterioration diagnosis velocity. | | | | | |

## ■ Default assignment

| Input signal | Corresponding parameters | Factory default values [*1]<br>(): decimal | Factory default setup state | | |
|---|---|---|---|---|---|
| | | | Position control | Velocity control | Torque control |
| | | | Signal name | Signal name | Signal name |
| SO1 output | Pr4.10 | 00030303h<br>(197379) | BRK-OFF | BRK-OFF | BRK-OFF |
| SO2 output | Pr4.11 | 00101010h<br>(1052688) | EX-OUT1 | EX-OUT1 | EX-OUT1 |
| SO3 output | Pr4.12 | 00010101h<br>(65793) | ALM | ALM | ALM |

*1 Factory default values are arranged in the following order, with two hexadecimal digits for each.

00/Torque Control/Velocity Control/Position Control or Full-closed Control (8 hexadecimal digits)

You can also refer to Pr4.00 “SI1 input selection” below or Pr4.10 “SO1 output selection” for specific examples.

## ■ When changing and using the output signal assignment

Change the following parameters to change the output signal assignment.

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 10 | C | SO1 output selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SO1 output.<br>This parameter is set using the hexadecimal display standard.<br>After displaying in hexadecimal format, set for each control mode as shown below.<br>00yyyyxxh: Position control/full-closed control<br>00yyxxyyh: Velocity control<br>00xxyyyyh: Torque control<br>Enter the function No. into the “xx” portion.<br>For details on function numbers, see *“Function No. table”* below. |
| 4 | 11 | C | SO2 output selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SO2 output.<br>The setup method is the same as for Pr4.10. |
| 4 | 12 | C | SO3 output selection | 0 to 00FFFFFFh | — | Sets the assignment function for the SO3 output.<br>The setup method is the same as for Pr4.10. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Output signal related parameters

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 34 | A | Zero-speed | 10 to 20000 | r/min | Sets the detection threshold value for zero speed (ZSP). |

*1 For attributes, see *“6.2 Object Dictionary List”* .

Function No. table

—: N/A

| Signal name | Symbol<br>External output | Setup value |
|---|---|---|
| Invalid | – | 00h |
| Alarm output | ALM | 01h |
| Servo-ready output | S-RDY | 02h |
| External brake release signal | BRK-OFF | 03h |
| Positioning complete | INP | 04h |
| Speed arrival output | AT-SPEED | 05h |
| Torque limit signal output | TLC | 06h |
| Zero-speed detection signal | ZSP | 07h |
| Velocity coincidence output | V-COIN | 08h |
| Warning output 1 | WARN1 | 09h |
| Warning output 2 | WARN2 | 0Ah |
| Position command on/off signal | P-CMD | 0Bh |
| Positioning complete 2 | INP2 | 0Ch |
| Output during velocity limit | V-LIMIT | 0Dh |
| Alarm attribute output | ALM-ATB | 0Eh |
| Speed command on/off output | V-CMD | 0Fh |
| General-purpose output 1 | EX-OUT1 | 10h |
| set brake output (*1) | set brake | 11h |
| Servo-on status output | SRV-ST | 12h |
| Position comparison output | CMP-OUT | 14h |
| Deterioration diagnosis velocity output | V-DIAG | 15h |

*1 The set brake is output with the logic and output value of Obj.60FEh: “Digital outputs” :bit 0 inverted. When 1, the output signal turns off (Brakes are applied).

## ■ Precautions

1 The same output signal function can be assigned to more than one pin.

However, always set the same output logic. When the same function is used in multiple control modes their output logics must be matched.

When output logic is set differently, the output signal state is indefinite.

2 The output transistor will always be OFF for output pins set to disabled, but this will not affect EtherCAT communication response.

3 Do not use setup values other than those listed in the table.

4 External brake release signal (BRK-OFF), set brake output and position comparison output (CMP-OUT) must be set for all control modes when used. When only one or two control modes are set, either Err33.4.0 “Output function number error 1 protection” or Err33.5.0 “Output function number error 2 protection” will occur.

5 Between when the servo driver control power is turned on and initialization is completed, the output transistor will turn OFF if the control power is off, mid-reset, or the front display is any of the following. Design the system to ensure that this does not pose a problem.






6 Control mode is forcibly switched inside this product according to its operation status, regardless of commands from the host device. Because this operation also affects output signal processing, it is generally recommended to assign the same function to each terminal in all modes.

The conditions for forcibly switching control modes are shown below.

| Operation status if this product | Control mode after forced switching |
|---|---|
| When using Set-up Support Software (PANATERM ver.7) to perform frequency characteristics analysis | ● During position loop characteristics analysis: Position control<br>● During velocity closed-loop characteristics analysis: Velocity control<br>● During torque speed (automatic) analysis: Position control<br>● During torque speed (vertical) analysis: Velocity control<br>● During torque speed (normal) analysis: Torque control |
| During trial run via Set-up Support Software (PANATERM ver.7) | ● Position control |
| Operations with descriptions of “forcible position control” using various deceleration to stop functions ( *“8.12”* to *“8.15”* ) | ● Position control |
| During retracting operations | ● Position control |

7 The uppermost bit (80h) is used as a reserved bit, so it is outside the judgment target of Err33.4.0 “Output function number error 1 protection” or Err33.5.0 “Output function number error 2 protection” . Therefore, even if the uppermost bit is set to 1, no error occurs.

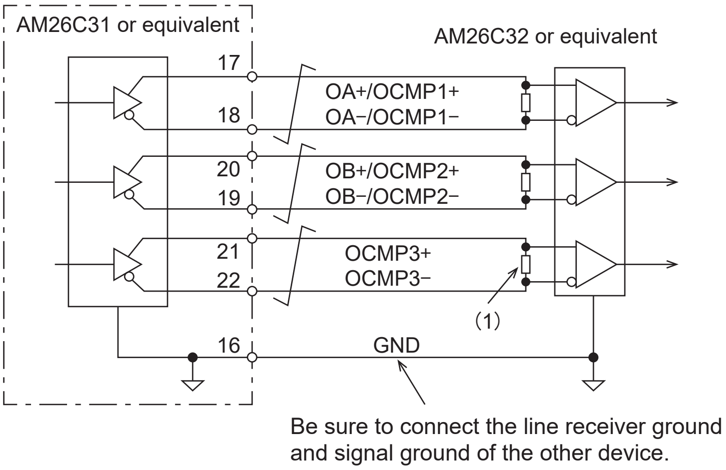
A signal corresponding to a setup value excluding the uppermost bit is assigned. For example, if the setup value is 81h, the signal is assigned as 01h (alarm output).

#### 3.2.5.5.2 Encoder Output Signal/Position Comparison Output Signal

**■ Output signal circuit**

Differential output of the frequency-divided encoder signal or external scale outputs (A-/B-phase) through each line driver (RS422 or equivalent).

The host device should receive these with a line receiver. When using a line receiver for receipt, be sure to install a terminating resistor (approx. 330 Ω, see (1) in the figure below) between line receiver inputs.



| Pin No. | Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|---|
| 17 | OA+/OCMP1+ | A-phase output/position comparison output 1 | P | S | T | – |
| 18 | OA-/OCMP1- | | | | | |
| 20 | OB+/OCMP2+ | B-phase output/position comparison output 2 | P | S | T | – |
| 19 | OB-/OCMP2- | | | | | |
| 21 | OCMP3+ | Position comparison output 3 | P | S | T | – |
| 22 | OCMP3- | | | | | |

- The frequency-divided encoder signal processed is output by a differential line driver signal equivalent to RS422.
- The ground of the line driver for the output circuit is connected to the signal ground (GND) and is not insulated.
- The maximum output pulse frequency is 4 Mpulse/s (after being multiplied by 4).
- Pr4.47 “Pulse output selection” can be set to 1 and used as position comparison output.

| Pin No. | Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|---|
| 16 | GND | Signal ground | – | – | – | – |

- Signal ground.
- Connect this terminal to the ground of the line receiver of the other device.

### 3.2.5.6 Other

| Pin No. | Symbol | Signal name | Related mode | | | Communications monitor |
|---|---|---|---|---|---|---|
| Shell | FG | Frame ground | – | – | – | – |

- Connected to the protective earth terminal inside the servo driver.

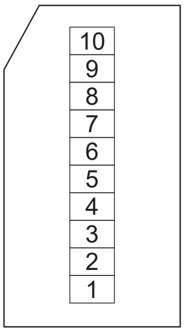
## 3.2.6 Wiring to Connector X5 (Connecting to External Scale)

### 3.2.6.1 Connector Specifications

Used to connect to an external scale.

This connector is compatible with both the multi-function type and application specialized type.

**Pinout diagram**



* Connector (Plug): MUF-PK10K-X (made by J.S.T. Mfg. Co., Ltd.) or equivalent

| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| External scale power supply output | EX5V | 1 | Provides power to external scales (for serial signals and ABZ-phase signals). (*1) (*2) |
| | EX0V | 2 | Connect with the signal ground using the external scale power supply output ground. |
| External scale signal input/output (Serial signal) | EXPS | 3 | Serial signal<br>Sending and receiving |
| | /EXPS | 4 | |
| External scale signal input/output (ABZ-phase signal) | EXA | 5 | A-/B-/Z-phase pulse signals are received in parallel<br>Supported speed: approx. 4 Mpulse/s (after being multiplied by 4) (*3) |
| | /EXA | 6 | |
| | EXB | 7 | |
| | /EXB | 8 | |
| | EXZ | 9 | |
| | /EXZ | 10 | |
| Frame ground | FG | Shell | Connected to the earth terminal inside the servo driver. |

*1 EX5V power supply output for external scale is 5 V ±5 %, 300 mA MAX.

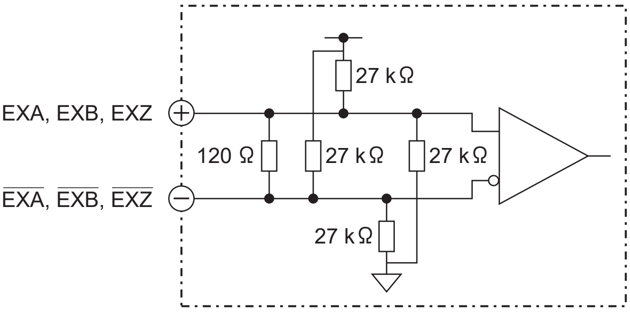
A customer-supplied power supply is necessary if using an external scale with a consumption current higher than this.

Also, some external scales may take time to initialize when powering on. In such a case, it can be handled by adjusting the power-up wait time, which is a function of the servo driver.

*2 If the external scale is powered by an external power supply, the EX5V pin should be open to prevent external voltage from being supplied to this pin.

*3 Note that if the duty ratio of the input signal waveform from the external scale is not 50%, it may not be read correctly.

**Signal interface**



+: 5-, 7-, and 9-pin

-: 6-, 8-, and 10-pin

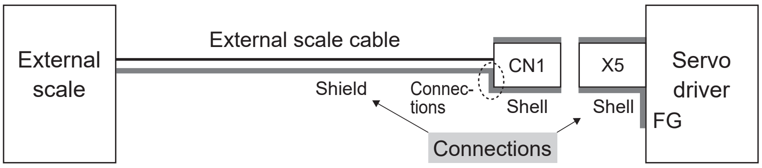
**— Precautions —**

- This product supports two types of external scales for serial signals: incremental type and absolute type. Please visit the Panasonic website to check if the external scale of the manufacturer you are using is compatible.
- We recommend a scale ratio of1/40 ≦ External scale ratio ≦ 20480 for external scales.
  Increasing the external scale ratio may increase operating noise.

### 3.2.6.2 Key Points on Wiring

- Wire the signals from the external scale to the X5 connector of the external scale.
- The core wire used to connect to the external scale cable should be a stranded wire of 0.18 $mm^2$ or more. Use a shielded twisted-pair wire.
- Keep cable lengths within 20 m. If using a long cable lengths, double wiring (with the wires connected in parallel) is recommended for the cable connecting to the external scale in order to slightly reduce the impact of voltage drops on the 5 V power supply.
- Make sure to connect the jacket of the external scale side cable shield to the shell (FG) of the driver connector X5.
  Note that the relay cable shield and the shell (FG) of connector X5 are connected via connecting the shell of the external scale-side cable connector plug CN1 and the external scale-side cable shield.

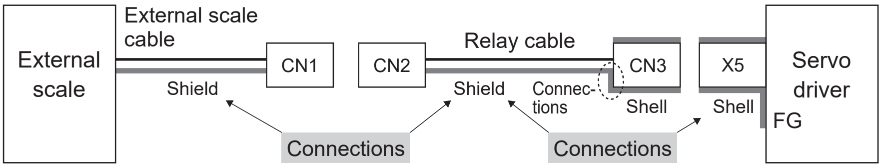
**When there is no relay cable**



* The connector X5 shell is connected to the servo driver FG.

- Connect the relay cable shield to the external scale-side cable shield when using a relay cable for the external scale connection. Also make sure to connect the relay cable shield to the shell (FG) of the connector X5 on the driver-side too.
  Note that the relay cable shield and the shell (FG) of connector X5 are connected via connecting the shell of the relay cable connector plug CN3 and the relay cable shield.

**When there is a relay cable**

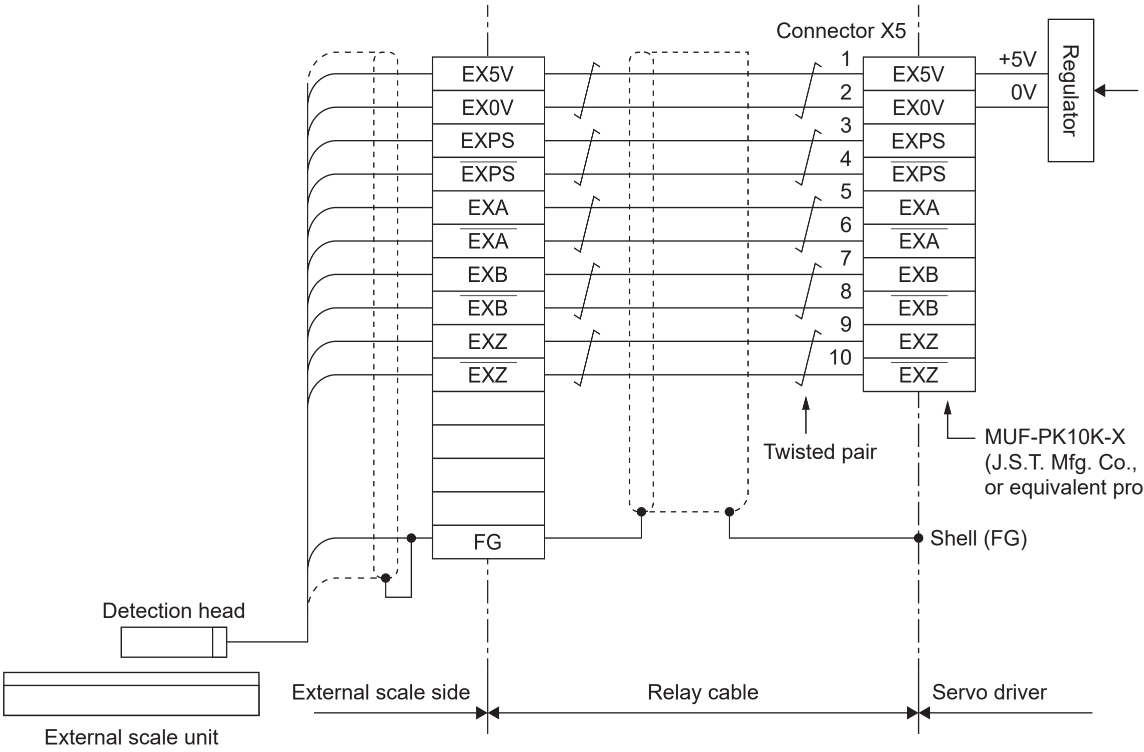


* The connector X5 shell is connected to the servo driver FG.

- Keep as much distance from the main circuit (L1, L2, L3, L1C, L2C, U, V, W ⏚) wiring as possible (at least 30 cm). Do not pass the wires through the same duct or bundle them together.
- Do not connect anything to the vacant pins of the X5 connector.
- If the external scale is powered by an external power supply, the EX5V pin should be open to prevent external voltage from being supplied to this pin. Connect the external power supply of 0 V (GND) to EX0V (connector X5: 2-pin) of the driver to eliminate potential difference.

### 3.2.6.3 Wiring Example

The wiring diagram of the X5 connector is shown below.

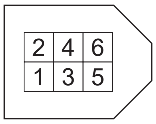


## 3.2.7 Wiring to Connector X6 (Connecting to Encoder)

### 3.2.7.1 Connector Specifications

Connect the encoder relay cable to the X6 connector.

**Pinout diagram**

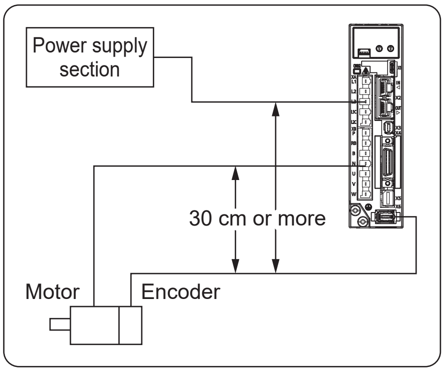


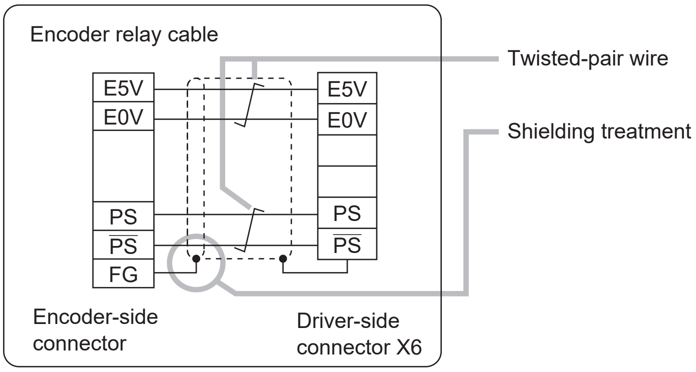
| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| Encoder power supply output | E5V | 1 | Encoder power supply. |
| | E0V | 2 | Connect with the signal ground using the encoder power supply output ground. |
| Absolute encoder battery output (*1) | BTP-O | 3 | Use the battery output (positive+) to connect the connector X4 absolute encoder battery output BTP-I. |
| | BTN-O | 4 | Use the battery output (negative-) to connect the connector X4 absolute encoder battery output BTN-I. |
| Encoder signal input/output | PS | 5 | Serial signal<br>Sending and receiving |
| | $\overline{PS}$ | 6 | |
| Frame ground | FG | Shell | Connected to the earth terminal inside the servo driver. |

*1 When directly connecting the battery to the encoder connection cable, do not connect this terminal to anything.

For details on the optional encoder relay cable and connector, see *"12.4 Optional Parts"* .

### 3.2.7.2 Key Points on Wiring





- Maintain at least a 30 cm distance from the main circuit wiring (L1, L2, L3, L1C, L2C, U, V, W,⏚). Do not pass the wires through the same duct or bundle them together.

Check the description below if making your own encoder relay cable.

- Refer to the wiring diagram in the figure above for details on the wiring.
- Select cables and wires to ensure that the DC input voltage of the connector on the encoder side is within 5 V ±5 %.

  Reference:

  Use stranded, highly bend-resistant, shielded twisted pair wire with a cross-section area of min. 0.18 mm$^2$ (24 AWG) if the cable length is max. 10 m. Optional accessories are listed in *"12.4.4 Relay Cable for Encoder"* .
- Use twisted-pair wire for the corresponding signal/cable wiring.

- Shield relay cables in the following manner.
  - Driver-side shield jacket
    Connect to connector X6 shell
  - Motor-side shield jacket
    Connect to FG terminal
- Do not connect anything to the empty terminals of each connector.

### 3.2.7.3 Wiring Example

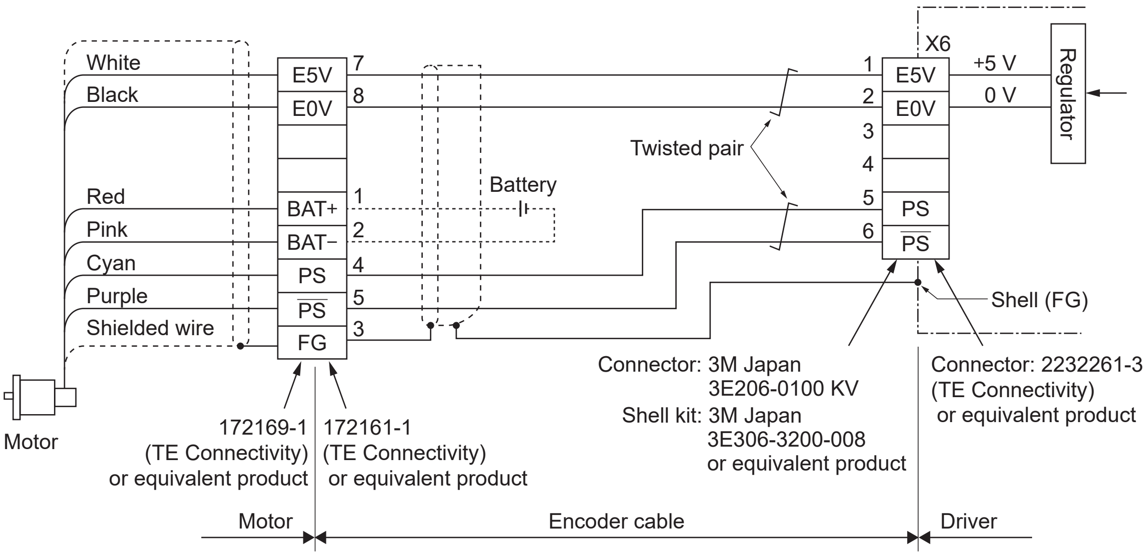
Suitable wiring is required according to the encoder of the motor used.

#### 3.2.7.3.1 When Using Multi-turn Data From an Absolute Encoder

When constructing an absolute system.

**Lead wire-type motor (for multi-turn data)**

MHMG 50 W and 1000 W (□80)



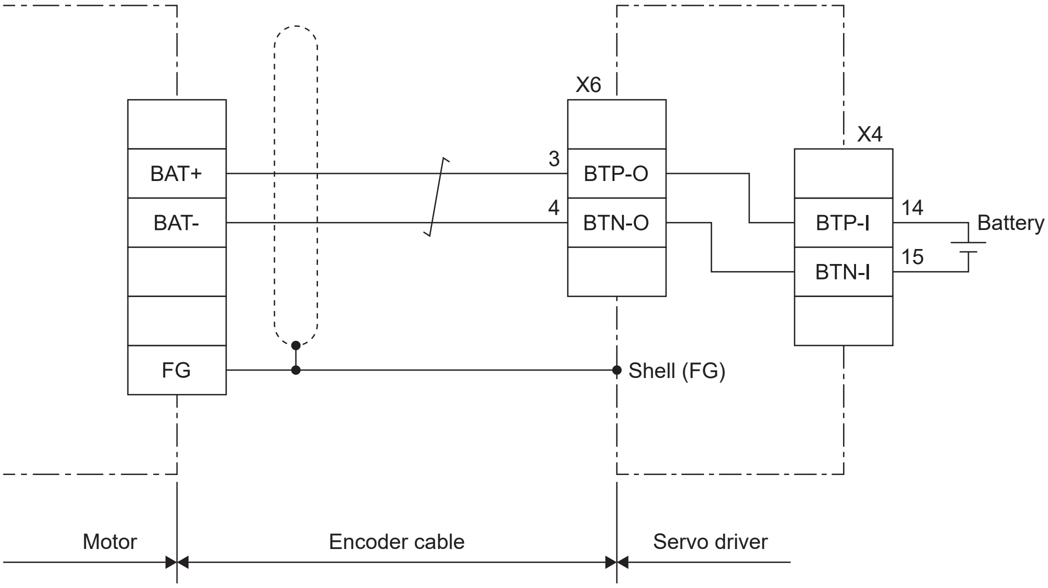
### ■ Connecting the absolute encoder battery

1. Connecting on the motor side using optional accessories (recommended)
   - Connect between encoder connectors BAT+ (1-pin) and BAT- (2-pin) on the motor side as shown in *“Lead wire-type motor (for multi-turn data)”* . In practice, a relay cable or other means is used between the battery and the BAT+ and BAT- terminals.
   - For the actual connection method, see *“2.4.2 Battery for Absolute Encoder”* .
2. Directly connect to motor side
   - Connect a battery directly between encoder connectors BAT+ (1-pin) and BAT- (2-pin) on the motor side as shown in *“Lead wire-type motor (for multi-turn data)”* .
   - Batteries and cables must be purchased by the customer. The recommended battery is the Toshiba Lifestyle ER6V 3.6 V. Consult the battery manufacturer for information on the configuration of the battery's peripheral circuit and how to refresh the battery.

3 Connecting on the driver side

- Connect the battery between BTP-I (14-pin) and BTN-I (15-pin) of the X4 connector and to BAT+ (1-pin) and BAT- (2-pin) of the motor via BTP-O (3-pin) and BTN-O (4-pin) of the X6 connector as shown in *"When connecting a battery to X4"* .
- Batteries and cables must be purchased by the customer. The recommended battery is the Toshiba Lifestyle ER6V 3.6 V. Consult the battery manufacturer for information on the configuration of the battery's peripheral circuit and how to refresh the battery.

**When connecting a battery to X4**



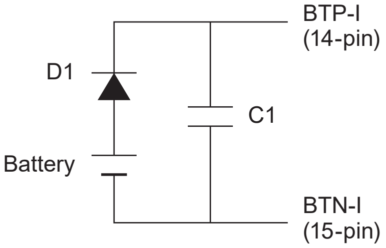
**— Precautions —**

- When directly connecting the battery to the motor-side encoder connector (connecting "1"), do not connect anything to connector X6 3-pin and 4-pin.
- For battery boxes and battery connection cables, use the optional relay cable or prepare a cable yourself.

**Notes**

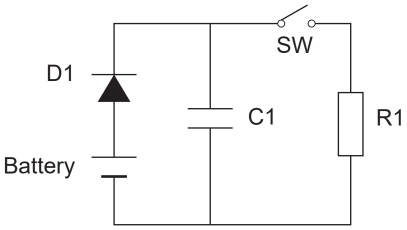
- The following is the configuration used for optional accessories. The following information is only provided for reference when implementing connections 2 and 3. Please consult the battery manufacturer for the final configuration.
  - Connect a diode to prevent charging and an electric double layer capacitor to reduce voltage drop against the battery, as shown in *"Protection Circuit"* . Note that with lithium batteries, the voltage may drop temporarily (voltage delay phenomenon) when the battery begins to discharge current. Connect an electric double layer capacitor to reduce this voltage drop. Also, use diodes of a type with low leakage current.
  - As shown in *"Battery Refresh Circuit"* , connect a resistor when refreshing the battery.
  - Do not connect anything to BTP-O (3-pin) or BTN-O (4-pin) of the X6 connector.

**Protection Circuit**



C1 (electric double layer capacitor) : 0.1 μF
D1: Diode (low leakage current)

**Battery Refresh Circuit**



C1 (electric double layer capacitor) : 0.1 μF
D1: Diode (low leakage current)
R1: 220 Ω
SW: Switch (closed during refresh)

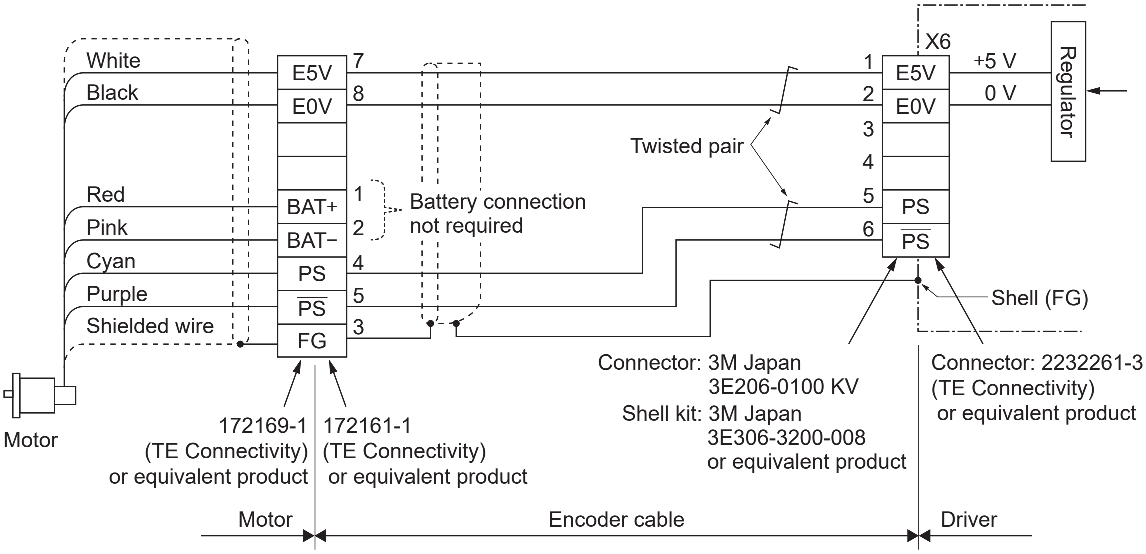
### 3.2.7.3.2 When Not Using Multi-turn Data From an Absolute Encoder

When using as an incremental encoder or single-turn absolute encoder.

**Lead wire-type motor (without multi-turn data)**

When using as an incremental encoder or single-turn absolute encoder.

MHMG 50 W and 1000 W (□80)



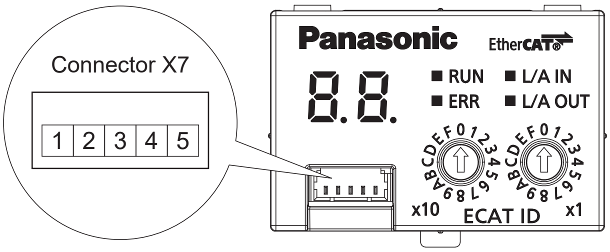
## 3.2.8 Wiring to Connector X7 (Connecting to External Monitor)

### 3.2.8.1 Connector Specifications

The connector X7 of the front panel is for monitor output.

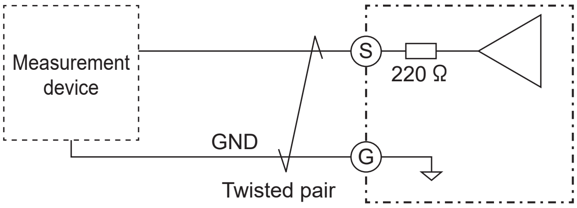
The monitor output has two systems of analog output signals for monitoring.

Output signals can be switched by parameter settings.



| Name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| Analog monitor output 1 | AM1 | 1 | Outputs analog signals for the monitor. Parameter settings alter the meaning of output signals. |
| Analog monitor output 2 | AM2 | 2 | |
| Signal ground | GND | 3 | Connected to the signal ground. |
| NC | – | 4 | Do not connect. |
| NC | – | 5 | Do not connect. |

**Signal interface**



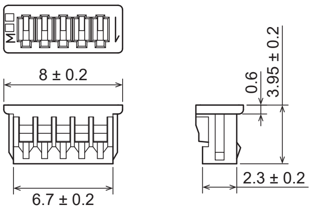
S: 1- and 2-pin

G: 3-pin

- Output signal amplitude is ±10 V.

**Cable-side Connector Specifications**

| Cable-side connectors | | Manufacturer |
|---|---|---|
| Part | Product number | |
| Connector | 51021-0500 | Molex Japan LLC |
| Connector pin | 50058-8020 | Molex Japan LLC |



- When switching analog monitor output signal types

Change the following parameters to change the analog monitor output signal types.

## ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All operation statuses |
| Other | ● Extended version 1 or later software version |

## ■ Setup value

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 16 | A | Type of analog monitor 1 | 0 to 35 | — | Selects the type of monitor for analog monitor 1.<br>For details on output specifications, see *“Operation”* “Analog monitor types”. |
| 4 | 17 | A | Analog monitor 1 output gain | 0 to 214748364 | [Pr4.16 monitor unit] /V | Sets the analog monitor 1 output gain.<br>When Pr4.16 = 0 “Motor speed,” 1 V is output when the setup value for the motor speed [r/min] = Pr4.17. |
| 4 | 18 | A | Type of analog monitor 2 | 0 to 35 | — | Selects the type of monitor for analog monitor 2.<br>For details on output specifications, see *“Operation”* “Analog monitor types”. |
| 4 | 19 | A | Analog monitor 2 output gain | 0 to 214748364 | [Pr4.18 monitor unit] /V | Sets the analog monitor 2 output gain.<br>When Pr4.18 = 4 “Torque command”, 1 V is output when the setup value for the torque command [%] = Pr4.19. |
| 4 | 21 | A | Analog monitor output setup | 0 to 2 | — | Selects the analog monitor output format<br>0: Signed data output -10 V to 10 V<br>1: Absolute data output 0 V to 10 V<br>2: Data output with offset 0 V to 10 V (5 V center)<br>For details on output specifications, see *“Operation”* “Analog monitor types”. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

### Analog monitor types

The table below shows the monitor types that are set with Pr4.16 “Type of analog monitor 1” and Pr4.18 “Type of analog monitor 2” . Set the conversion gain corresponding to the unit for each type with Pr4.17 “Analog monitor 1 output gain” and Pr4.19 “Analog monitor 2 output gain” . When gain setting = 0, the gain listed on the right side of the table below is automatically applied.

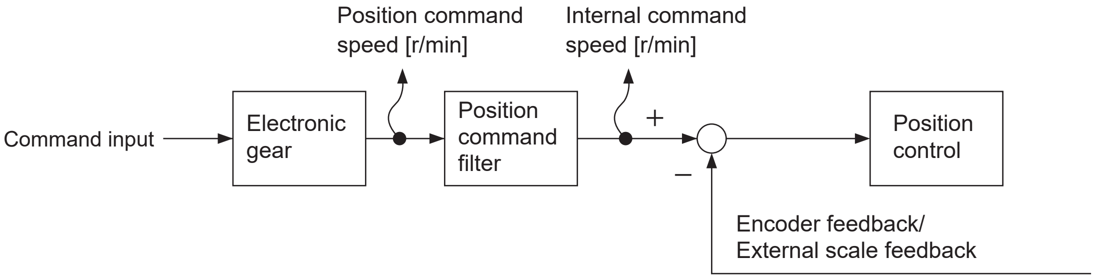
| Pr4.16/Pr4.18 Setup value | Monitor type | Unit | Output gain [1/V] when Pr4.17/ Pr4.19 = 0 |
|---|---|---|---|
| 0 | Motor speed | r/min | 500 |
| 1 | Position command speed (*2) | r/min | 500 |
| 2 | Internal position command speed (*2) | r/min | 500 |
| 3 | Velocity control command | r/min | 500 |
| 4 | Torque command | % | 33 |
| 5 | Command position deviation (*3) | pulse (command unit) | 3000 |

| Pr4.16/Pr4.18 Setup value | Monitor type | Unit | Output gain [1/V] when Pr4.17/ Pr4.19 = 0 |
|---|---|---|---|
| 6 | Encoder position deviation (*3) | pulse (encoder unit) | 3000 |
| 7 | Full-closed deviation (*3) | pulse (external scale unit) | 3000 |
| 8 | Hybrid deviation | pulse (command unit) | 3000 |
| 9 | Voltage across PN | V | 80 |
| 10 | Regenerative load factor | % | 33 |
| 11 | Motor load factor | % | 33 |
| 12 | Positive direction torque limit | % | 33 |
| 13 | Negative direction torque limit | % | 33 |
| 14 | Velocity limit value | r/min | 500 |
| 15 | Inertia ratio | % | 500 |
| 16 | Reserved | — | — |
| 17 | Reserved | — | — |
| 18 | Reserved | — | — |
| 19 | Encoder temperature | °C | 10 |
| 20 | Driver temperature | °C | 10 |
| 21 | Encoder single-turn data (*1) | pulse (encoder unit) | 110000 |
| 22 | Reserved | — | — |
| 23 | Movement command status (*4) | — | — |
| 24 | Gain selection status (*4) | — | — |
| 25 | Positioning complete status | 0: Positioning incomplete<br>1: Positioning complete | (*6) |
| 26 | Alarm triggered state | 0: Alarm not triggered<br>1: Alarm triggered | (*6) |
| 27 | Motor power consumption | W | 100 |
| 28 | Motor power consumption (*5) | Wh | 100 |
| 29 | Manufacturer use (setting is prohibited) | — | — |
| 30 | Manufacturer use (setting is prohibited) | — | — |
| 31 | Reserved | — | — |
| 32 | Reserved | — | — |
| 33 | Reserved | — | — |
| 34 | Reserved | — | — |
| 35 | Driver derating monitor | % | 33 |

*1 The positive and negative directions of the monitor data basically follow the Polarity setting.

However, encoder single-turn data is always positive in the CCW direction.

*2 The position command speed is the pre-position command filter (smoothing, FIR filter) corresponding to the command input, and the internal command speed is post-filter.



*3 Position deviation calculation method (reference) differs depending on EtherCATcommunication, Set-up Support Software (PANATERM ver.7) , and analog monitors.

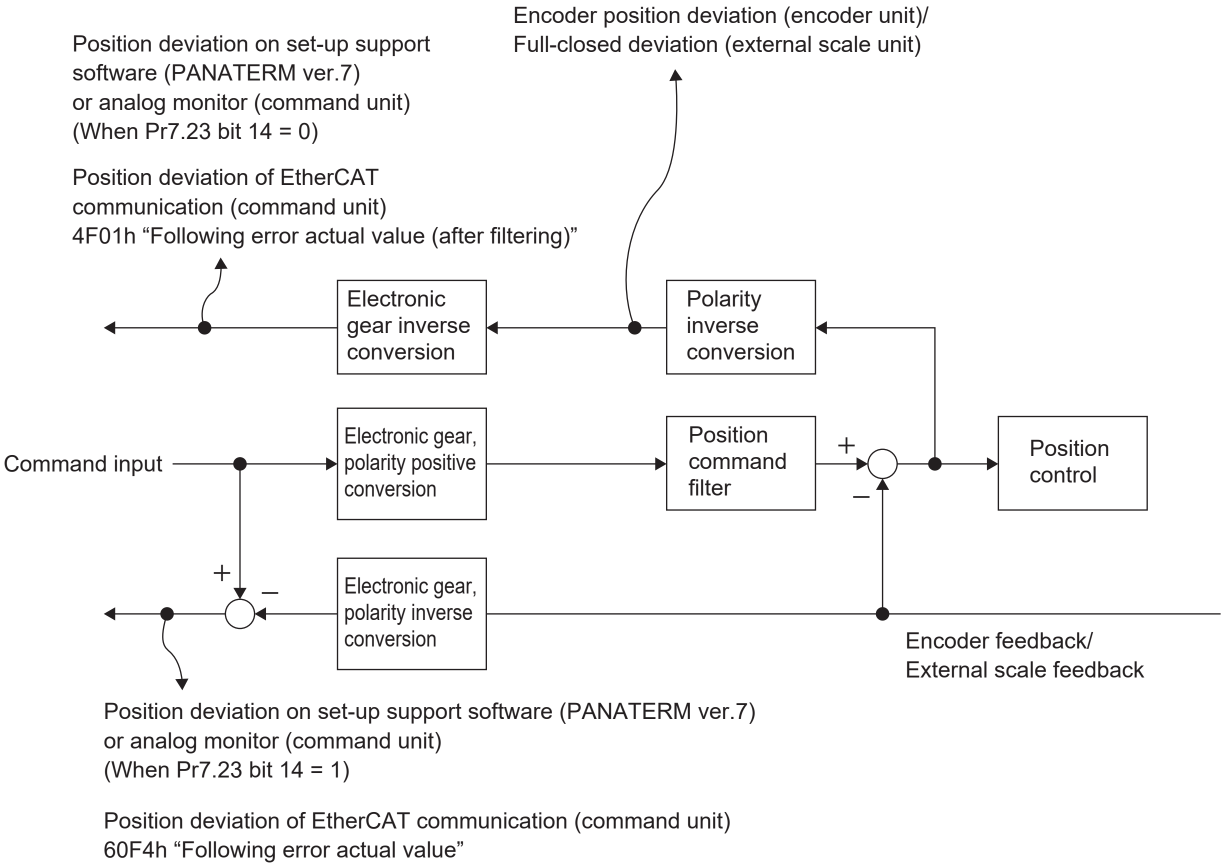
EtherCAT communication creates deviation corresponding to pre-position command filter command input

Set-up Support Software (PANATERM ver.7) and the analog monitor switches things as below depending on the settings in Pr7.23 “Communication function extended setup 2” :bit 14 "Command position deviation output switching".

Pr7.23 bit14 = 0: Deviation relative to post-position command filter command input

Pr7.23 bit14 = 1: Deviation relative to pre-position command filter command input

Details are shown in the figure below.



*4 For monitor types No. 23 and 24, digital signals are monitored using analog monitors, so the outputs are as shown in the table below regardless of Pr4.17 “Analog monitor 1 output gain” and Pr4.19 “Analog monitor 2 output gain” settings.

| Pr4.16/Pr4.18 | Monitor type | | Output voltage | |
|---|---|---|---|---|
| | | | 0 [V] | +5 [V] |
| 23 | Movement command status | Profile position control (pp) | 250 μs cycle period<br>Movement command ≠ 0 | 250 μs cycle period<br>Movement command = 0 |
| | | Cyclic position control (csp) | Communication cycle period<br>Movement command ≠ 0 | Communication cycle period<br>Movement command = 0 |

| Pr4.16/Pr4.18 | Monitor type | | Output voltage | |
|---|---|---|---|---|
| | | | 0 [V] | +5 [V] |
| 23 | Movement command status | Velocity control | Speed command ≠ 0 | Speed command = 0 |
| | | Torque control | Torque command ≠ 0 | Torque command = 0 |
| 24 | Gain selection status | | 2nd gain (incl. 3rd gain) | 1st gain |

*5 Outputs the motor power consumption per 30 minutes. The value is updated after 30 minutes.

e.g. When the motor operates for 30 minutes at 10 W motor power consumption

10 W × 0.5 h = 5 Wh

*6 The output gain is 0 V for unit 0 and 5 V for unit 1 regardless of Pr4.17 “Analog monitor 1 output gain” and Pr4.19 “Analog monitor 2 output gain” settings.

### Analog monitor output setup

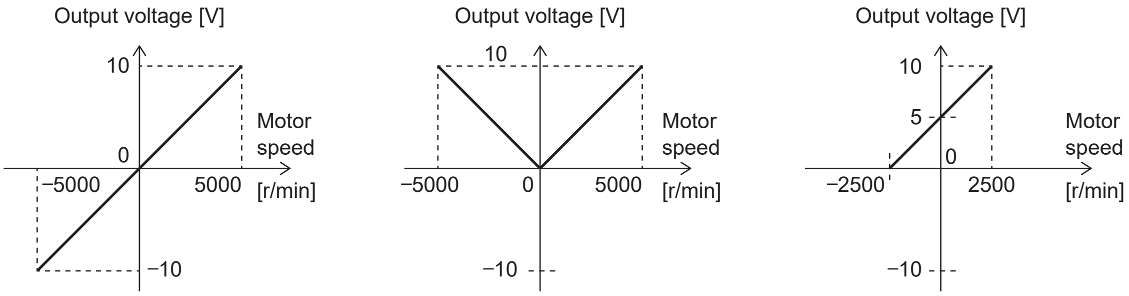
The following figure shows the output specifications when Pr4.21 “Analog monitor output setup” = 0, 1, and 2, respectively.

The figure below shows a case where the monitor type is motor speed and the conversion gain is 500 (1 V = 500 r/min).

Pr4.21=0 signed data output
(Output range: -10 to 10 V)

Pr4.21=1 absolute value data output
(Output range: 0 to 10 V)

Pr4.21=2 offset data output
(Output range: 0 to 10 V)



# 3.3 Brake System

## 3.3.1 Internal Brake

### 3.3.1.1 Overview

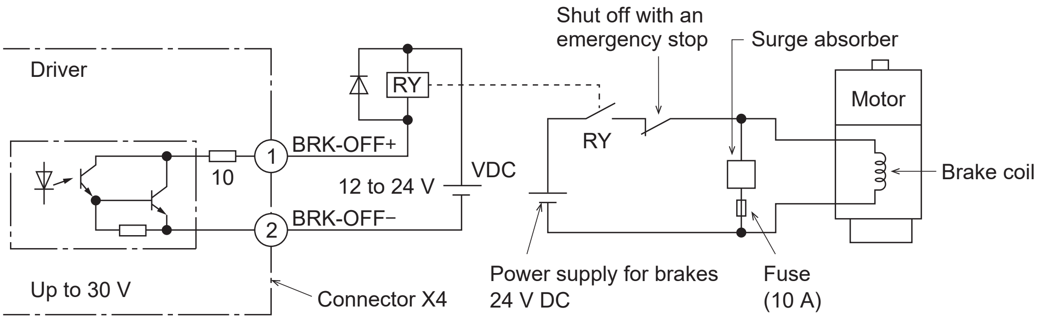
In applications where the motor drives the vertical axis, the brake built into the motor is used to hold and prevent the work (moving load) from falling due to gravity when the power to the driver is shut off and the motor is stopped.

**— Precautions —**

- The brake built into the motor is for “holding” purposes only, that is, to keep something stopped. Do not use it to “brake” or stop moving loads.

### 3.3.1.2 Example Connection

The figure below shows an example connection where the holding brake is controlled using the external brake release output signal (BRK-OFF) of the driver.



**— Precautions —**

- The brake coil has no polarity.
- The power supply for the brake is to be provided by the customer. Do not share the power supply (VDC) between the brake and the control signals.
- Install a surge absorber as shown in the figure above to suppress the surge voltage generated by the on and off action of the relay (RY). If using a diode, the time from holding brake release to brake engagement is sometimes slower than would be the case when using a surge absorber.
- Refer to *“12.4.13 Surge Absorber for Motor Brake”* for information on brake surge absorbers.
- Reactance of the cable varies depending on the cable length and may generate surge voltage. Select a surge absorber that can suppress the coil voltage of the relay and the voltage between the terminals of the holding brake.
- The current to be passed through the SO terminals must not exceed a rated current of 40 mA, a maximum current of 50 mA or an inrush current of 90 mA.

**Notes**

- The external brake release output is assigned to SO1 (X4: 1, 2 pin) as the default setting.

### 3.3.1.3 Output Timing of BRK-OFF Signal

- For holding brake release timing at power-on, or holding brake timing at servo-off while the motor is in operation or when the alarm is triggered, see the *“7.1 Startup Operation”* timing chart.

- With the parameter (Pr4.38 “Mechanical brake action at running setup” ), when at servo-off or if an alarm is triggered while the motor is in motion, you can set up a time between when the motor enters a free-run state from an excited state to when the BRK-OFF signal turns off (holding brake engaged). For details, see *“6 Object”* .

#### 3.3.1.4 Specifications

| Item | Unit | Applicable Models | | |
|---|---|---|---|---|
| | | MHMG5A<br>MHMG01 | MHMG02<br>MHMG04 | MHMG08<br>MHMG09 |
| Static friction torque (*1) | N·m | 0.38 or more | 1.6 or more | 3.8 or more |
| Armature pull in time (*2) | ms | Less than 35 | Less than 50 | Less than 70 |
| Armature release time (*2) (*3) | ms | Less than 20 | | |
| Releasing voltage (*1) | DC, V | 1 or more | | |
| Excitation voltage | DC, V | 24 ± 2.4 | | |
| Excitation current (with 24 V DC) (*2) | DC, A | 0.30 | 0.36 | 0.42 |
| Allowable braking energy | J | 39.2 | 105 | 185 |
| All allowable braking energy | J | $4.9 \times 10^3$ | $44.1 \times 10^3$ | $80.0 \times 10^3$ |
| Permissible angle acceleration | $rad/s^2$ | 30000 | | |

*1 Values at the time of shipping inspection by Panasonic.

*2 Representative values at 20 °C.

*3 DC cuts off when using a varistor (TND14V271K made by Nippon Chemi-con).

* This brake is a non-excitation brake.

* Armature pull in time and armature release times are the brake actuation delay times. Please check the actual state before actual use.

* The backlash for this brake should not exceed 2° at the time of shipping.

* The brake power supply is to be provided by the user (No polarity specified).

* The allowable braking energy stated above represents the amount of braking that can be performed in compliance with brake specifications.

(braking energy capable of performing a suction motion in consideration of braking temperature increases)

* The allowable braking energy may vary depending on wear during idling (when brakes are powered).

* The motor's life span is 10 million accelerations and decelerations at the permissible angle acceleration stated above (The number of accelerations and decelerations before brake backlash starts increasing rapidly).

* When using a varistor, it is recommended to connect protective parts, such as fuses, in series.

## 3.3.2 Dynamic Brake (DB)

### 3.3.2.1 Overview

Sizes A to D drivers come equipped with built-in dynamic brakes for emergency stopping.

The dynamic brake can be activated in the below scenarios.

1. When the main power supply is off
2. At servo-off
3. When protection function is activated
4. When over-travel inhibit input (NOT, POT) of connector X4 is activated

Under conditions “1” through “4” above, dynamic brake operation or free running can be selected using parameters during deceleration or after stopping.

The dynamic brake in sizes A to D drivers remains activated when the control power is off.

**— Precautions —**

- Dynamic brakes are for emergency stopping.

  Do not start or stop the device by turning the servo-on signal (SRV-ON) on or off. Doing so may damage the dynamic brake circuit built into the driver.

  When driven externally, the motor becomes a generator. A short-circuit current flows during dynamic brake operation regardless of whether the power supply is supplied with current. Continued external driving may cause the driver and motor to smoke or catch fire.
- Dynamic brakes are rated for a short time and should only be used for emergency stopping. If the dynamic brake is applied from the rated rotational velocity and below the recommended load inertia ratio, allow a stop time of at least 10 minutes.

### 3.3.2.2 Dynamic Brake Driving Conditions

The conditions for operating the dynamic brake can be configured by setting specific parameters.

Check the conditions chart below and apply settings that fit your usage environment.

#### 3.3.2.2.1 When the Main Power Supply is Off

The driving conditions of the dynamic brake from deceleration to stop due to the main power supply turning off can be set using the values in Pr5.07 “Sequence upon main power off” .

Check the chart below for driving conditions.

**Driving conditions settings from deceleration to stop due to main power supply off (Pr5.07)**

| Sequence upon main power off (Pr5.07) | Over-travel conditions | | | Deviation counter details |
|---|---|---|---|---|
| Set value of Pr5.07 ↓ | Mid-deceleration | Post-stop | | |
| | | When Pr6.36 = 0 | When Pr6.36 = 1 | |
| 0 | D B | D B | Operates via external signal | Clear |
| 1 | Free run | D B | | |
| 2 | D B | Free run | | |
| 3 | Free run | Free run | | |
| 4 | D B | D B | | |
| 5 | Free run | D B | | |
| 6 | D B | Free run | | |
| 7 | Free run | Free run | | |
| 8 | Emergency stop | D B | | |
| 9 | Emergency stop | Free run | | |

**Notes**

- If the Pr5.07 “Sequence upon main power off” setup value is 8 or 9, the torque limit value at emergency stop will be that of the setup values given in Pr5.11 “Torque setup for emergency stop” .

### 3.3.2.2.2 At Servo-Off

The driving conditions of the dynamic brake from deceleration to stop due to servo-off can be set using the values in Pr5.06 “Sequence at servo-off” .

Check the conditions chart below for the driving conditions.

**Driving conditions settings from deceleration to stop due to servo off (Pr5.06)**

| Sequence at servo-off (Pr5.06)<br>Set value of Pr5.06 | Over-travel conditions<br>Mid-deceleration | <br>Post-stop | <br>Deviation counter details |
|---|---|---|---|
| 0 | D B | D B | Clear |
| 1 | Free run | D B | |
| 2 | D B | Free run | |
| 3 | Free run | Free run | |
| 4 | D B | D B | |
| 5 | Free run | D B | |
| 6 | D B | Free run | |
| 7 | Free run | Free run | |
| 8 | Emergency stop | D B | |
| 9 | Emergency stop | Free run | |

**Notes**

- If the Pr5.06 “Sequence at servo-off” setup value is 8 or 9, the torque limit value at emergency stop will be that of the setup values given in Pr5.11 “Torque setup for emergency stop” .

### 3.3.2.2.3 When Protection Function is Activated

The driving conditions of the dynamic brake from deceleration to stop due to activation of protection functions can be set using the values in Pr5.10 “Sequence at alarm” .

Check the conditions chart below for the driving conditions.

**Driving conditions settings from deceleration to stop due to activation of protection function (Pr5.10)**

Sequence at alarm (Pr5.10)

| Set value of Pr5.10 | Over-travel conditions | | |
|---|---|---|---|
| | Mid-deceleration | Post-stop | Deviation counter details |
| 0 | DB | DB | Clear |
| 1 | Free run | DB | |
| 2 | DB | Free run | |
| 3 | Free run | Free run | |
| 4 | Operation A: Emergency stop<br>Operation B: DB | DB | |
| 5 | Operation A: Emergency stop<br>Operation B: Free run | DB | |
| 6 | Operation A: Emergency stop<br>Operation B: DB | Free run | |
| 7 | Operation A: Emergency stop<br>Operation B: Free run | Free run | |

**Notes**

- If the Pr5.10 “Sequence at alarm” setup value is between 4 and 7, operation A will be executed if the protection function supports emergency stopping, and operation B will be executed if the protection function does not support emergency stopping.

  The deviation counter that runs when the protection function is in operation will be cleared when the alarm is cleared.

**— Precautions —**

- Maintain the main circuit power supply throughout the deceleration to stop.

### 3.3.2.2.4 When Over-travel Inhibit Input (NOT, POT) is Activated

The driving conditions of the dynamic brake from deceleration to stop due to over-travel inhibit input (NOT, POT) can be set using the values in Pr5.05 “Sequence at over-travel inhibit” when Pr5.04 “Over-travel inhibit input setup” is 0.

Check the conditions chart below for the driving conditions.

**Driving conditions settings from deceleration to stop due to activation of over-travel inhibit input (NOT, POT) (Pr5.05)**

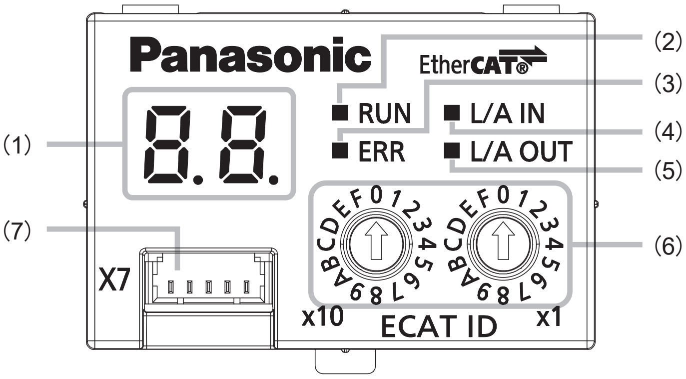
| Sequence at over-travel inhibit (Pr5.05) | Over-travel conditions | | | |
|---|---|---|---|---|
| | Mid-deceleration | | Post-stop | |
| Set value of Pr5.05 | Stopping method | Deviation counter details | Post-stop operation | Deviation counter details |
| 0 | D B | Clear | Torque command in the direction of over-travel inhibition = 0 | Retained |
| 1 | Free run | Clear | Torque command in the direction of over-travel inhibition = 0 | Retained |
| 2 | Emergency stop | Clear | Torque limit and torque command are as usual | Retained |

**Notes**

- If the Pr5.05 “Sequence at over-travel inhibit” setup value is 2, the torque limit value during deceleration will be Pr5.11 “Torque setup for emergency stop” .

## 3.4 Front Panel

### 3.4.1 Operation and Display of the Front Panel



| No. in image | Name | |
|---|---|---|
| (1) | 7-segment LED for display (2-digit) | |
| (2) | RUN LED (Green) | EtherCAT indicator |
| (3) | ERROR LED (Red) | |
| (4) | Link/Activity IN LED (Green) | |
| (5) | Link/Activity OUT LED (Green) | |
| (6) | Node address (Station Alias) setting rotary switch (2-digit)<br>Setting range: 0 to FF | |
| (7) | Analog monitor connector (X7) | |

### 3.4.2 Node Address

- The node address (Station Alias) 16 bit is limited to base 10 where Pr7.41 “Station Alias selection” is 0. The setup value is determined by the values of the Pr7.40 “Station alias settings (upper 8 bits)” and the two values of the rotary switch “Station alias settings (lower 8 bits)” on the front panel.

  Use the switches on the left and right to set the “Station alias settings (lower 8 bits)”.

| Station alias | | |
|---|---|---|
| Upper 8 bits | Lower 8 bits | |
| Parameter Pr7.40 setup values | Upper 4 bits<br>(MSD) | Lower 4 bits<br>(LSD) |
| | Left-side rotary switch setup value (*1) | Right-side rotary switch setup value (*1) |

*1 The range of setup values is between 0(00h) and 255(FFh).

(Example) When Station alias = 165 (A5h)

Set MSD=A, LSD=5

For a detailed explanation of node addresses (Station Alias), refer to *“4.2.5 Node Address”* .

- When setting the rotary switch, use a flathead screwdriver with the following specifications.

  Blade tip width: 2.6 mm or less

  Blade tip thickness: 0.6 mm or less
- Turn the rotary switch until you feel a click.
- The set node address (Station alias) is only loaded once when the control power is switched on.

Changes made after power-on are not reflected in the control.

Note that the setup values will be applied with the next power-on. To avoid unnecessary trouble, do not change the values of the rotary switch after the power supply is turned on.

### 3.4.3 7-Segment LED

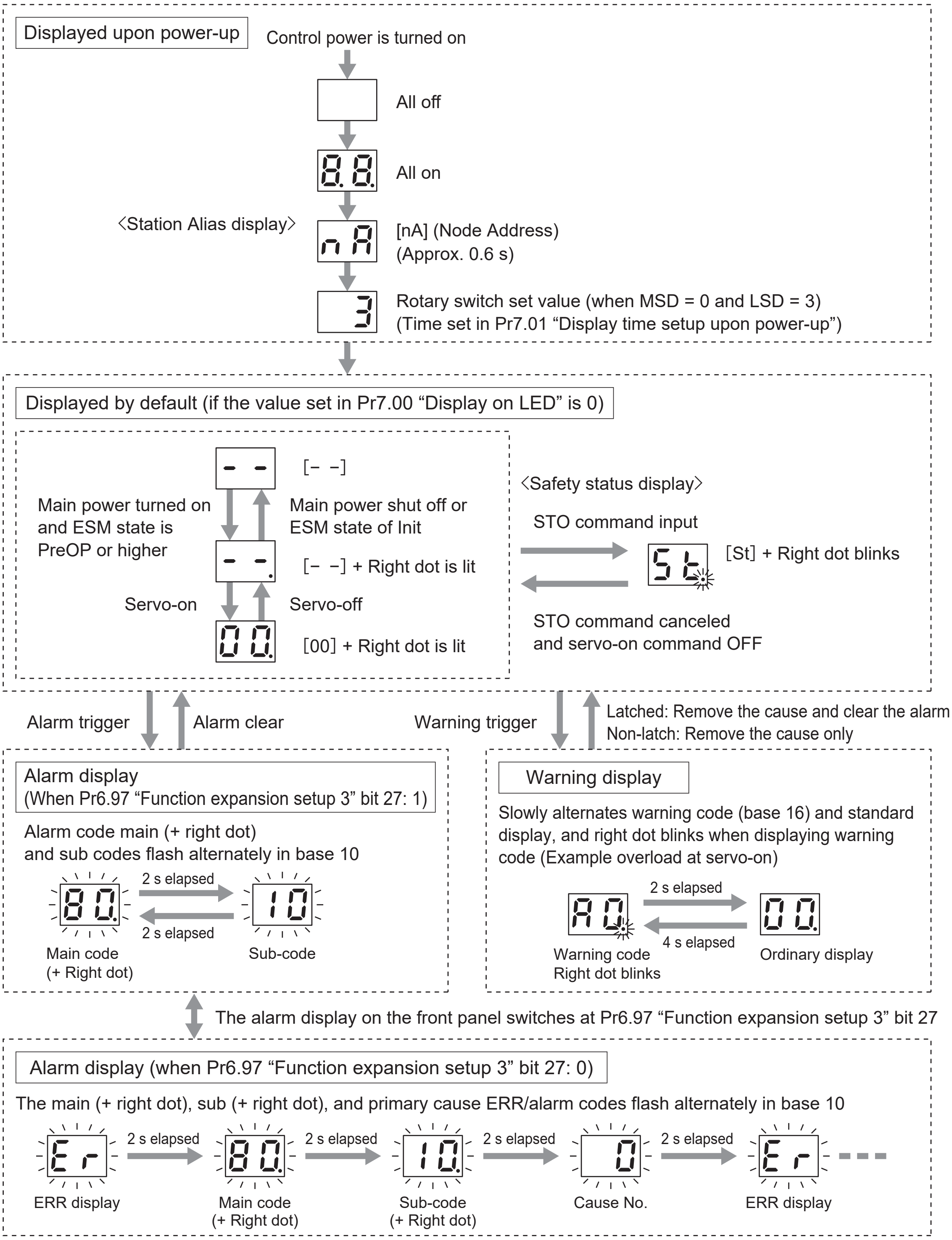
The 7-segment LED in the front panel displays the node address values set in the rotary switch when the control power is turned on. After that, it will display the values set up in Pr7.00 “Display on LED” .

An alarm number is displayed when an alarm is triggered. The display method is switched by the Pr6.97 “Function expansion setup 3” :bit 27 setting.

A warning number is displayed when a warning is triggered.

The diagram below shows the transition in states after the control power supply is turned on.

### 7-segment LED display



For main, sub, and primary cause numbers, one digit will be displayed for 0 to 9, and two digits for 10 to 90.

When a warning number is displayed, refer to *“10.3.2 List of Warning Functions”* to check the warning number and descriptions.

### 3.4.4 EtherCAT Indicators

There are RUN LED, ERROR LED, Link/Activity IN LED and Link/Activity OUT LED EtherCAT indicators.

The display specifications of RUN LED, ERROR LED, Link/Activity IN LED and Link/Activity OUT LED are given below.

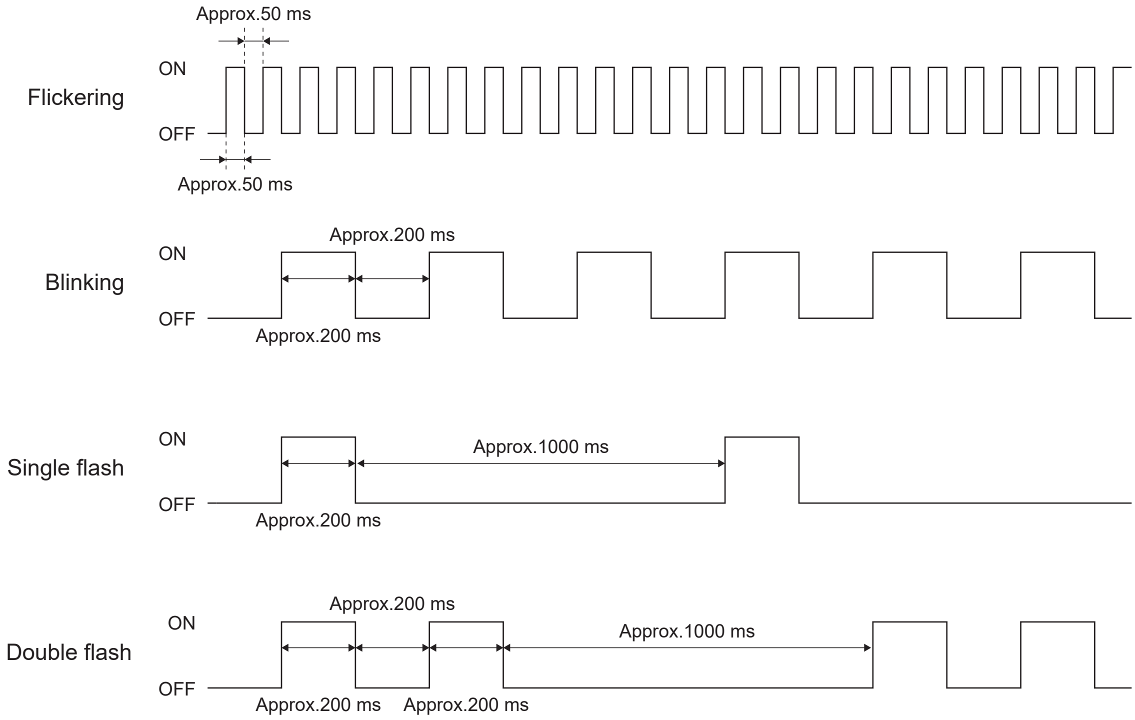
Indicator LEDs are located on the front panel. See *"3.4.1 Operation and Display of the Front Panel"* for a detailed description of the front panel.

| Network status LED | Display status | Description |
|---|---|---|
| RUN LED<br>Light color: green | OFF | ESM:INIT status |
| | Flickering | ESM:Bootstrap status |
| | Blinking | ESM:Pre-Operational status |
| | Single flash | ESM:Safe-Operational status |
| | ON | ESM:Operational status |
| ERROR LED<br>Light color: red | OFF | No generation of an alarm as defined by the AL Status code (Err80.0.0 to 7.0, Err81.0.0 to 7.0, and Err85.0.0 to 7.0 from among the EtherCAT communication-related errors) |
| | Blinking | Communication setting error |
| | Single flash | Synchronization event error |
| | Double flash | Application watchdog timeout |
| | Flickering | Initialization error |
| | ON | PDI error |
| Link/Activity IN LED<br>Link/Activity OUT LED<br>Light color: green | OFF | LINK not established |
| | Flickering | LINK established, data transmission/reception available |
| | ON | LINK established, data transmission/reception unavailable |

- The RUN LED shows the status of the ESM (EtherCAT State Machine).
- The ERROR LED shows the status of the alarm defined by AL status code.
- Link/Activity IN and Link/Activity OUT LEDs show the operational status and LINK status of the physical layer of each port.

**Notes**

- Refer to the following for the specifications of the four flashing patterns of LED indicators, besides off and on.



# 4 Communication Specifications

## 4.1 Network Outline

### 4.1.1 Supported Control Modes

This product supports seven control modes.

Position control modes (pp, csp, hm), velocity control modes (pv, csv), and torque control modes (tq, cst) are used with semi-closed control. Semi-closed control executes control by feeding motor encoder data back to the servo driver.

In addition to semi-closed control, position control modes are also used with full-closed control. Full-closed control uses an external scale to directly detect the position of the machine to be controlled, provide feedback, and perform position control. Please see *"7.6 Full-closed Control"* for a detailed description of full-closed control mode.

Use Pr0.01 "Control mode setup" to choose between semi-closed and full-closed control.

Control modes (pp, csp, hm, pv, csv, tq, cst) are confirmed and set with the EtherCAT communication object.

Use Obj.6502h:00h "Supported drive modes" to confirm supported control modes.

Use Obj.6060h:00h "Modes of operation" to set a control mode.

Use Obj.6061h:00h "Modes of operation display" to display the current control mode.

Please see *"6.6.4 Control Mode Confirmation and Setup"* for a detailed description of each object.

—: None

| Class | Control mode | | Abbreviation | Description |
|---|---|---|---|---|
| — | NOP | NOP | NOP | A mode for sending temporary invalid data immediately after the network is established. |
| Semi-closed control | Profile position control mode | Profile position mode | pp | A position control mode in which the host device commands the target position, target speed, and acceleration/deceleration (parameters), and operates by generating position commands inside the servo driver. |
| | Cyclic position control mode | Cyclic synchronous position mode | csp | A position control mode in which the host device generates a position command, and operates by updating (sending) a command position in a command updating cycle. |
| | Homing position control mode | Homing mode | hm | This is a position control mode in which the host device designates settings such as the homing method, operating speed, etc., generates position commands inside the servo driver, and performs the homing operation. |
| | Profile velocity control mode | Profile velocity mode | pv | This is a velocity control mode in which the host device designates settings such as the target speed and acceleration/deceleration, and operates by generating position commands inside the servo driver. |
| | Cyclic velocity control mode | Cyclic synchronous velocity mode | csv | A velocity control mode in which the host device generates a speed command, and operates by updating (sending) the command speed in a communication cycle. |
| | Profile torque control mode | Torque profile mode | tq | This is a torque control mode in which the host device designates settings such as the target torque, and acceleration/deceleration, and operates by generating position commands inside the servo driver. |
| | Cyclic torque control mode | Cyclic synchronous torque mode | cst | A torque control mode in which the host device generates a torque command, and operates by updating (sending) the command torque in a communication cycle. |
| Full-closed control | Profile position control mode | Profile position mode | pp | A position control mode in which the host device commands the target position, target speed, and acceleration/deceleration (parameters), and operates by generating position commands inside the servo driver. |
| | Cyclic position control mode | Cyclic synchronous position mode | csp | A position control mode in which the host device generates a position command, and operates by updating (sending) a command position in a command updating cycle. |
| | Homing position control mode | Homing mode | hm | This is a position control mode in which the host device designates settings such as the homing method, operating speed, etc., generates position commands inside the servo driver, and performs the homing operation. |

**Notes**

- Check the host device operating manual, since the control modes that can actually be used depend on the host device specifications.

## 4.1.2 Control Modes: Overview

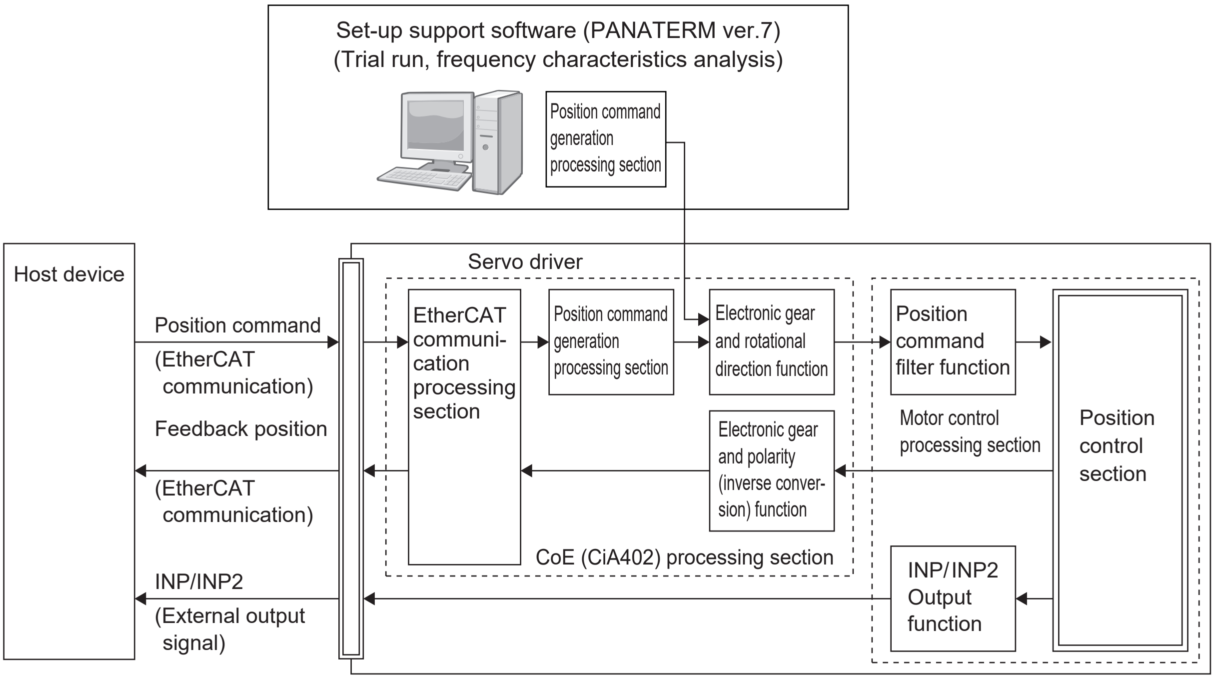
### 4.1.2.1 Position Control Modes

Position control is performed on the basis of the EtherCAT communication object position commands input from the host device.

Position control modes include the following modes, specified according to the EtherCAT communication object.

- Profile Position Control (pp): A control mode in which the host device designates the target position, target speed, and acceleration/deceleration, and generates position commands inside the servo driver.
- Cyclic Position Control (csp): A control mode in which the host device updates the command position in the command updating cycle.
- Homing Position Control (hm): A control mode in which the host device designates the homing method, operating velocity, etc.; generates position commands inside the servo driver, and performs the homing operation.

Please see *"6.6.5 Position Control Function (pp, csp, ip, hm)"* , *"7.3 Position Control"* , and *"7.6 Full-closed Control"* for a detailed description of position control modes.



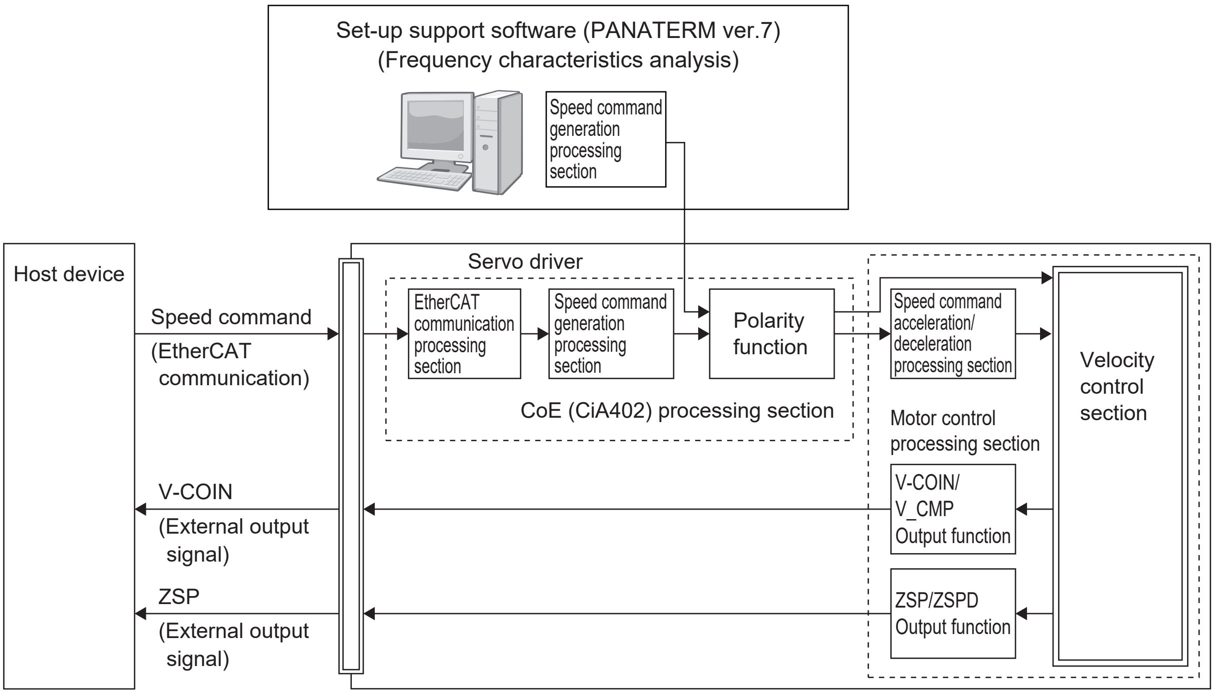
#### 4.1.2.2 Velocity Control Modes

Velocity control mode performs control on the basis of the EtherCAT communication command velocity commands input from the host device.

Velocity control modes include the following modes, specified according to the EtherCAT communication object.

- Profile Velocity Control (pv): A control mode in which the host device designates the target speed, acceleration/ deceleration, etc., and generates position commands within the servo driver.
- Cyclic Velocity Control (csv): A control mode in which the command speed generated by the host device is updated in the communication cycle.

Please see *"6.6.6 Velocity Control Function (pv, csv)"* and *"7.4 Velocity Control"* for a detailed description of velocity control modes.



#### 4.1.2.3 Torque Control Modes

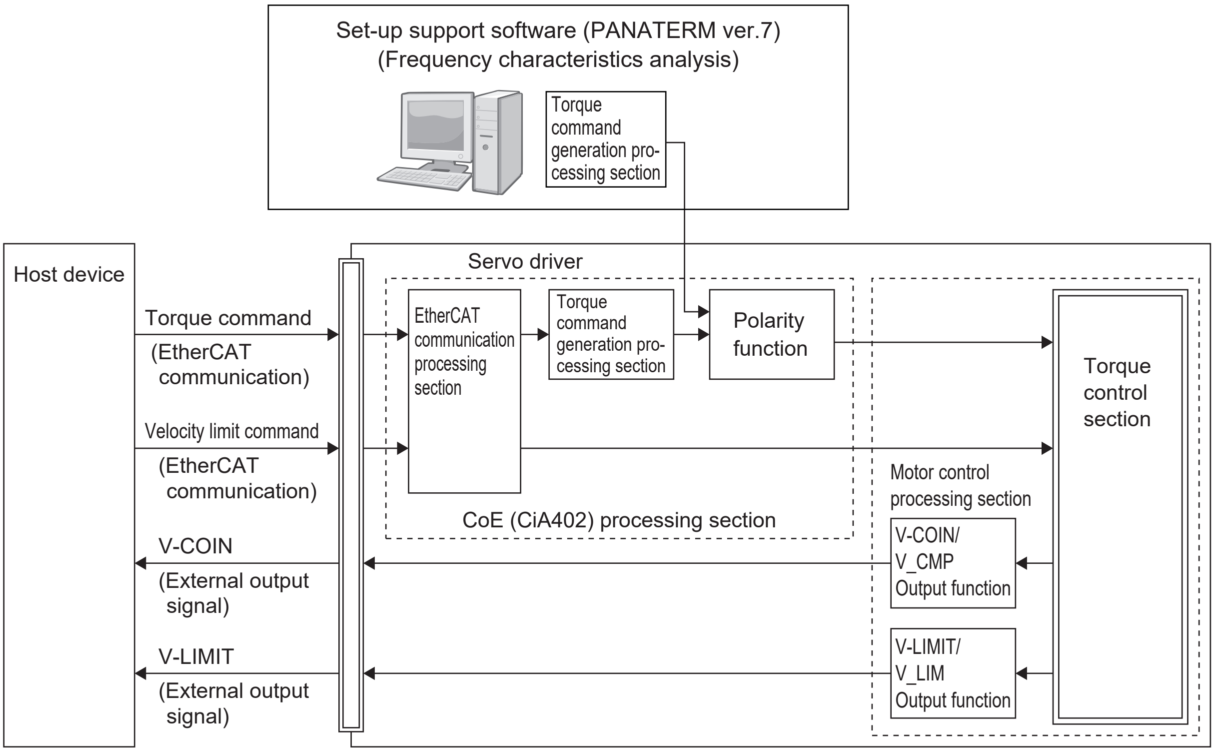
Torque control is performed on the basis of the EtherCAT communication object torque commands input from the host device.

In addition to the torque command, a velocity limit value is required for torque control. The servo driver not only controls torque, but controls it so that the velocity does not exceed the velocity limit.

Torque control modes include the following modes, specified according to the EtherCAT communication object.

- Profile Torque Control (tq): A control mode in which the host device designates the target torque, acceleration/deceleration, etc., and generates position commands inside the servo driver.
- Cyclic Torque Control (cst): A control mode in which the command torque generated by the host device is updated in the communication cycle.

Please see *"6.6.7 Torque Control Function (tq, cst)"* and *"7.5 Torque Control"* for a detailed description of torque control modes.



### 4.1.3 Basic Network Specifications

| Item | Specifications |
|---|---|
| Physical Layer | 100BASE-TX (IEEE 802.3) |
| Baud rate | 100 Mbps (Full duplex) |
| Topology | Line (Please inquire regarding non-line connections) |
| Connection cable | Twisted-pair CAT5e |
| Cable length | Between nodes: Maximum 100 m |
| Number of sub devices (axes) connected | Maximum 65535 |
| Communication ports | 2 ports (RJ45 connector) |
| EtherCAT Indicators<br>(LED) | [RUN] RUN indicator (Green)<br>[ERR] ERROR indicator (Red)<br>[L/A IN] Port 0 Link/activity indicator (Green)<br>[L/A OUT] Port 1 Link/activity indicator (Green) |
| Station Alias (ID) | Setting range: 0 to 65535<br>Setup Method (1)<br>Lower 8 bits: Rotary switch, 2-digit (front panel)<br>Upper 8 bits: Object 3740h<br>Setup Method (2)<br>SII saved value |
| Explicit Device ID | Supported |
| Device profile | CoE (CANopen over EtherCAT) |
| SyncManager | 4 |
| FMMU | 3 |
| Modes of Operation<br>(Control modes)<br>Abbreviation: Op-mode | ● Semi-closed control (S)<br>• Position Control: Profile position control (pp), cyclic position control (csp), homing position control (hm)<br>• Velocity Control: Profile velocity control (pv), cyclic velocity control (csv)<br>• Torque Control: Profile torque control (tq), cyclic torque control (cst)<br>● Full-closed control (F)<br>• Position Control: Profile position control (pp), cyclic position control (csp), homing position control (hm)<br>The above semi-closed control and full-closed control are switched by parameters.<br>Switches between the abovementioned pp, csp, hm, pv, csv, tq, cst according to the EtherCAT communication object |
| Touch Probe | 2ch positive edge, negative edge |
| Synchronous mode | DC (SYNC0 event synchronization) (DC 64 bit)<br>SM2 (SM2 event synchronization)<br>FreeRUN (asynchronous) |
| Cycle time (DC, SM2 communication cycle) | 62.5 μs, 125 μs, 250 μs, 500 μs, 1 ms, 2 ms, 4 ms, 8 ms, 10 ms<br>pp, pv, tq are not compatible with 62.5 μs and 125 μs<br>hm is not compatible with 62.5 μs |
| Communication object | SDO (Service Data Object)<br>PDO (Process Data Object) |
| SDO message | Supported: SDO Request, SDO Response, SDO information, Emergency message<br>Not currently supported: Complete Access |
| Free PDO Mapping | Supported |
| Maximum number of PDO assignments | RxPDO: 4 Table<br>TxPDO: 4 Table |

| Item | Specifications |
|---|---|
| Maximum data length | RxPDO: 32 bytes<br>TxPDO: 32 bytes |
| Diagnosis Object | Supported: Diagnosis message |
| Command Object | Not currently supported |
| Shift time | Only input (response) in 62.5 μs increments is supported |
| csp position command correction when there is a communication error | Supported |
| Object editor | Supported (object value can be monitored and changed using Set-up Support Software (PANATERM ver.7) ) |
| EtherCAT communication confirmation pending Set-up Support Software (PANATERM ver.7) operation | Supported |

## 4.2 EtherCAT Communication Protocol

### 4.2.1 EtherCAT Frame Configuration

EtherCAT is an Ethernet-based real-time controllable industrial communication protocol.

This protocol extends the IEEE 802.3 Ethernet standard and enables transmission of data within the standard Ethernet frame without any infrastructural changes.

Setting the Ethernet Header EtherType to 88A4 causes Ethernet Data to process Ethernet frames as EtherCAT frames.

EtherCAT frame consists of a EtherCAT Header and one or more EtherCAT Datagrams, with theEtherCAT Datagram being further subdivided.

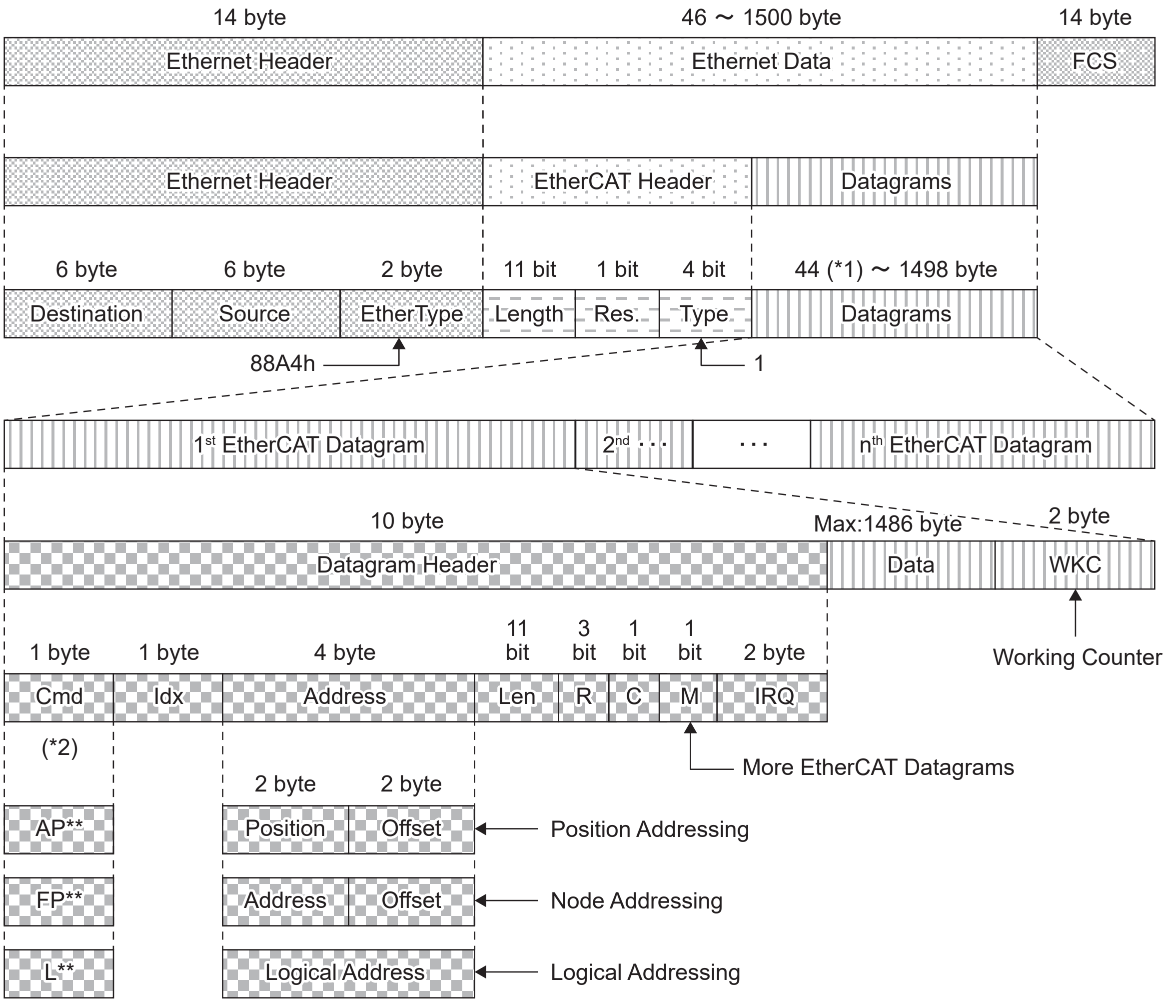
Always set EtherCAT Header Type to 1. By setting Type=1, ESC (EtherCAT Sub Device Controller) will process frames as EtherCAT frames. If Type does not = 1, ESC will not process frames as EtherCAT frames and the frames will not be processed. The way frames are handled when Type does not = 1 is set via “ESC DL Control” in the ESC register. Please see *“4.2.2 ESC (EtherCAT Sub Device Controller) Address Space”* for a detailed description of the ESC Register.

**— Precautions —**

- In consideration of the possibility that noise, etc., could prevent this product from properly receiving EtherCAT frames from the main device, please confirm on the main device side that this product has properly received EtherCAT frames.

  If the product fails to successfully receive EtherCAT frames, retransmit the EtherCAT frames from the main device.

### Ethernet Frame Configuration and EtherCAT Frame Configuration



*1 If an Ethernet frame is shorter than 64 bytes, 1 to 32 bytes are added.

(Ethernet header + Ethernet data + FCS)

*2 The addressing mode is specified by Cmd in the datagram header of a EtherCAT datagram.

The Cmd and addressing modes supported are as indicated in the below table.

—: N/A

| Cmd | Addressing modes | Abbrevi-ation | Name | Description |
|---|---|---|---|---|
| 00h | — | NOP | No operation | Nothing is performed. |
| 01h | Position Addressing | APRD | Auto increment physical read | Each sub device increments the address.<br>When a frame with the address value 0 is received, the requested read operation is performed. |
| 02h | | APWR | Auto increment physical write | Each sub device increments the address.<br>When a frame with the address value 0 is received, the requested write operation is performed. |
| 03h | | APRW | Auto increment physical read write | Each sub device increments the address.<br>When a frame with the address value 0 is received, the requested read and write operations are performed.<br>This command cannot be used for the process data RAM area (1000h to FFFFh). |
| 04h | Node Addressing | FPRD | Configured address physical read | When the address value matches the station address, each sub device executes the requested read operation. |
| 05h | | FPWR | Configured address physical write | When the address value matches the station address, each sub device executes the requested write operation. |
| 06h | | FPRW | Configured address physical read write | When the address value matches the station address, each sub device executes the requested read and write operations.<br>This command cannot be used for the process data RAM area (1000h to FFFFh). |
| 07h | — | BRD | Broadcast read | Each sub device executes the requested read operation. |
| 08h | | BWR | Broadcast write | Each sub device executes the requested write operation. |
| 09h | | BRW | Broadcast read write | Each sub device executes the requested read and write operations.<br>This command cannot be used for the process data RAM area (1000h to FFFFh). |
| 0Ah | Logical Addressing | LRD | Logical read | When the logical address value matches the logical memory zone specified in the FMMU request, each sub device executes the requested read operation. |
| 0Bh | | LWR | Logical write | When the logical address value matches the logical memory zone specified in the FMMU request, each sub device executes the requested write operation. |
| 0Ch | | LRW | Logical read write | When the logical address value matches the logical memory zone specified in the FMMU request, each sub device executes the required read and write operations.<br>When using this command for process data RAM area (1000h to FFFFh), set the same address in the Logical Start Address of FMMU for both Input and Output. |
| 0Dh | Position Addressing | ARMW | Positional physical read /multiple write | Each sub device increments the address.<br>The sub device that receives a frame with the address value 0 executes the requested read operation.<br>Another sub device executes the write operation. |
| 0Eh | Node Addressing | FRMW | Configured address physical read /multiple write | Each sub device compares the values of the address and the station address.<br>The sub device with the compared and matching value executes the requested read operation.<br>Another sub device executes the write operation. |
| 0Fh to FFh | — | — | (Reserved) | — |

### 4.2.2 ESC (EtherCAT Sub Device Controller) Address Space

The product has 12 Kbytes of physical address space.

Of this, the first 4 Kbytes (0000h to 0FFFh) are used as register space, and the next 8 Kbytes are used as a process data RAM area.

Representative registers are presented in the below table. For a detailed description of registers and registers that are not in the table below, see *“ESC Register Information”* in *“1.4.3 EtherCAT Reference Documents”* .

—: N/A

| ESC Register Byte Address | Length (byte) | Description | Initial Value (*1) |
|---|---|---|---|
| ESC Information | | | |
| 0000h | 1 | Type | 90h |
| 0001h | 1 | Revision | 06h |
| 0002h to 0003h | 2 | Build | 0530h |
| 0004h | 1 | FMMUs supported | 08h |
| 0005h | 1 | SyncManagers supported | 08h |
| 0006h | 1 | RAM Size | 3Bh |
| 0007h | 1 | Port Descriptor | 0Fh |
| 0008h to 0009h | 2 | ESC Features supported | 008Ch |
| Station Address | | | |
| 0010h to 0011h | 2 | Configured Station Address | — |
| 0012h to 0013h | 2 | Configured Station Alias | — |
| ⋮ | | | |
| DL (Data Link Layer) | | | |
| ⋮ | | | |
| 0100h to 0103h | 4 | ESC DL Control | — |
| ⋮ | | | |
| 0110h to 0111h | 2 | ESC DL Status | — |
| AL (Application Layer) | | | |
| 0120h to 0121h | 2 | AL Control | — |
| 0130h to 0131h | 2 | AL Status | — |
| 0134h to 0135h | 2 | AL Status Code | — |
| ⋮ | | | |
| PDI (Physical Device Interface) | | | |
| 0140h | 1 | PDI Control | 80h |
| 0141h | 1 | ESC Configuration | 0Ch |
| 0150h | 1 | PDI Configuration | E0h |
| 0151h | 1 | SYNC / LATCH PDI Configuration | 00h |
| 0152h to 0153h | 2 | Extended PDI Configuration | — |
| ⋮ | | | |
| Watchdogs | | | |
| 0400h to 0401h | 2 | Watchdog Divider | — |
| 0410h to 0411h | 2 | Watchdog Time PDI | — |
| 0420h to 0421h | 2 | Watchdog Time Process Data | — |
| 0440h to 0441h | 2 | Watchdog Status Process Data | — |

| ESC Register Byte Address | Length (byte) | Description | Initial Value (*1) |
|---|---|---|---|
| 0442h | 1 | Watchdog Counter Process Data | – |
| 0443h | 1 | Watchdog Counter PDI | – |
| | | ⋮ | |
| FMMU (Fieldbus Memory Management Units) | | | |
| 0600h to 062Fh | 3x16 | FMMU [2:0] | – |
| +0h to 3h | 4 | Logical Start Address | – |
| +4h to 5h | 2 | Length | – |
| +6h | 1 | Logical Start bit | – |
| +7h | 1 | Logical Stop bit | – |
| +8h to 9h | 2 | Physical Start Address | – |
| +Ah | 1 | Physical Start bit | – |
| +Bh | 1 | Type | – |
| +Ch | 1 | Activate | – |
| +Dh to Fh | 3 | Reserved | – |
| | | ⋮ | |
| Distributed Clocks (DC) - SYNC Out Unit | | | |
| 0981h | 1 | Activation | – |
| | | ⋮ | |
| 0984h | 1 | Activation Status | – |
| 098Eh | 1 | SYNC0 Status | – |
| | | ⋮ | |
| 0990h to 0993h | 4 | Start Time Cyclic Operation / Next SYNC0 Pulse | – |
| | | ⋮ | |
| 09A0h to 09A3h | 4 | SYNC0 Cycle Time | – |
| | | ⋮ | |

*1 The initial value is that at the time ESC starts up. This may be changed by CPU firmware, etc.

### 4.2.3 SII (Sub Device Information Interface) EEPROM

This product stores EtherCAT sub divide information (ESI) in the 16 Kbit EEPROM area.

The SII EEPROM structure is shown in the table below. Word addressing is used for ESI.

SII EEPROM structure

| SII EEPROM Word Address | +0h | +1h | +2h | +3h | +4h | +5h | +6h | +7h |
|---|---|---|---|---|---|---|---|---|
| 0000h | EtherCAT Sub Device Controller Configuration Area | | | | | | | |
| 0008h | Vendor ID | | Product Code | | Revision Number | | Serial Number | |
| 0010h | Hardware Delays | | | | Bootstrap Mailbox Config | | | |
| 0018h | Mailbox Sync Man Config | | | | | Reserved | | |
| 0020h<br>⋮<br>0030h | Reserved | | | | | | | |
| 0038h | Reserved | | | | | | Size | Version |
| 0040h<br>⋮ | Additional Information (Subdivided in Categories) | | | | | | | |
| | Category Strings | | | | | | | |
| | Category Generals | | | | | | | |
| | Category FMMU | | | | | | | |
| | Category SyncManager | | | | | | | |
| | Category TxPDO and RxPDO for each PDO | | | | | | | |

Among SII EEPROM structures, EEPROM word addresses 0000h to 003Fh are assigned as SII areas.

In addition, 0000h to 0007h from within the SII area are allocated as the ESC configuration area.

ESC configuration area

—: N/A

| SII EEPROM Word Address | Name | Description | ESC Register Word Address | Data Type | Initial Value |
|---|---|---|---|---|---|
| 0000h | PDI Control | Initial value for PDI control register | 0140h<br>0141h | Unsigned16 | 0C80h |
| 0001h | PDI Configuration | Initial value for PDI configuration register | 0150h<br>0151h | Unsigned16 | 00E0h |
| 0002h | Pulse Length of SYNC Signals | Initial value for SYNC signal pulse length | 0982h<br>0983h | Unsigned16 | 0064h |
| 0003h | Extended PDI Configuration | Initial value for extended PDI configuration register | 0152h<br>0153h | Unsigned16 | 0000h |
| 0004h | Configured Station Alias | Initial value for Station Alias (ID)<br>For details, see *"4.2.5 Node Address"* . | 0012h<br>0013h | Unsigned16 | 0000h |
| 0005h | Reserved | Reserved | — | BYTE [4] | — |
| 0006h | | | | | |
| 0007h | Checksum | ESC configuration area checksum | — | Unsigned16 | — |

After control power is turned on, 0004h "Configured Station Alias" is automatically read out from the ESC configuration area by the ESC.

The 0004h "Configured Station Alias" read is written to the ESC register.

If values subsequent to the SII EEPROM change are reflected in the ESC register, turn on the control power supply again.

ESC registers other than those in the table above are set to the initial values found in *“ESC Register Information”* in *“1.4.3 EtherCAT Reference Documents”* .

**Notes**

- Basically, do not change anything other than 0007h “Checksum” and 0004h “Configured Station Alias” .

  If changes are necessary, 0004h “Configured Station Alias” and 0007h “Checksum” must be changed together.

  For a details, see *“ESC Register Information”* in *“1.4.3 EtherCAT Reference Documents”* .

Details of the SII EEPROM connected to the ESC configuration area

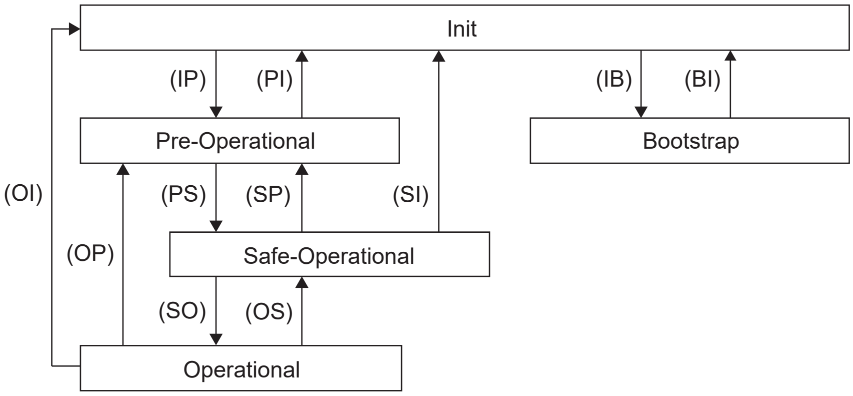
—: N/A

| SII EEPROM Word Address | Name | Description | ESC Register Word Address | Data Type | Initial Value |
|---|---|---|---|---|---|
| 0008h<br>0009h | Vendor ID | Vendor ID | — | Unsigned32 | 066Fh |
| 000Ah<br>000Bh | Product Code | Product Code | — | Unsigned32 | (Varies according to product) |
| 000Ch<br>000Dh | Revision Number | Revision Number | — | Unsigned32 | (Varies according to product) |
| 000Eh<br>000Fh | Serial Number | Serial Number | — | Unsigned32 | (Varies according to product) |
| 0010h | Execution Delay | Execution Delay | — | Unsigned16 | 0000h |
| 0011h | Port 0 Delay | Port 0 Delay | — | I16 | 0000h |
| 0012h | Port 1 Delay | Port 1 Delay | — | I16 | 0000h |
| 0013h | Reserved | Reserved | — | BYTE [2] | — |
| 0014h | Bootstrap Receive Mailbox Offset | The offset for the receiving mailbox in bootstrap status<br>(Main Device > Sub Device) | — | Unsigned16 | 1000h |
| 0015h | Bootstrap Receive Mailbox Size | The size of the receiving mailbox in bootstrap status<br>(Main Device > Sub Device) | — | Unsigned16 | 0100h |
| 0016h | Bootstrap Send Mailbox Offset | The offset for the sending mailbox in bootstrap status<br>(Sub Device > Main Device) | — | Unsigned16 | 1200h |
| 0017h | Bootstrap Send Mailbox Size | The size of the sending mailbox in bootstrap status<br>(Sub Device > Main Device) | — | Unsigned16 | 0100h |
| 0018h | Standard Receive Mailbox Offset | The offset for the receiving mailbox in standard status<br>(Main Device > Sub Device) | — | Unsigned16 | 1000h |
| 0019h | Standard Receive Mailbox Size | The size of the receiving mailbox in standard status<br>(Main Device > Sub Device) | — | Unsigned16 | 0100h |

| SII EEPROM Word Address | Name | Description | ESC Register Word Address | Data Type | Initial Value |
|---|---|---|---|---|---|
| 001Ah | Standard Send Mailbox Offset | The offset for the sending mailbox in standard status<br>(Sub Device > Main Device) | — | Unsigned16 | 1200h |
| 001Bh | Standard Send Mailbox Size | The size of the sending mailbox in standard status<br>(Sub Device > Main Device) | — | Unsigned16 | 0100h |
| 001Ch | Mailbox Protocol | Supported Mailbox protocol | — | Unsigned16 | 000Ch |
| 001Dh | Reserved | Reserved | — | BYTE [66] | — |
| ⋮ | | | | | |
| 003Dh | | | | | |
| 003Eh | Size | EEPROM size (This product features 16 Kbit EEPROM) | — | Unsigned16 | 000Fh |
| 003Fh | Version | Version (Fixed as 1) | — | Unsigned16 | 0001h |
| 0040h | Data by category | | | | |
| ⋮ | | | | | |

## 4.2.4 ESM (EtherCAT State Machine)

### EtherCAT application layer status (ESM status) transition diagram



* Bootstrap is not currently supported.

**— Precautions —**

- In the figure above, abbreviations for state transitions such as (IP) are used only in ESM state transition figures.

  (Abbreviation example)

  (IP): Init→Pre-Operational

  (PS): Pre-Operational→Safe-Operational etc.

  Note that if the same abbreviation is used elsewhere in this document (i.e. Not in an ESM state transition figure) the meaning will differ.

## ESM state list

—: N/A

| ESM state | Actions that can be taken in each status | Communication operation | | | | Trial run<br>Frequency characteristics analysis function (FFT function) operation |
|---|---|---|---|---|---|---|
| | | CoE | | | EoE | |
| | | SDO (Mailbox) send/ receive | PDO send (S to M) | PDO receive (M to S) | Ethernet (Mailbox)<br>Set-up Support Software (PANATERM ver.7) connection | |
| Init | The communication section is being initialized, and SDO (Mailbox) send/receive and PDO send/receive are disabled | No | No | No | No | Yes |
| Pre-operational<br>(Abbreviation: Pre-OP) | SDO (Mailbox) send/receive is enabled | Yes | No | No | Yes | Yes |
| Safe-operational<br>(Abbreviation: Safe-OP) | PDO send (sub device to main device) enabled in addition to SDO (Mailbox) send/ receive | Yes | Yes<br>(*1) | No | Yes | Yes |
| Operational<br>(Abbreviation: OP)<br>(*2) | All SDO (Mailbox) send/receive and PDO send/receive are enabled | Yes | Yes<br>(*1) | Yes | Yes | Yes |
| Bootstrap<br>(Abbreviation: Boot)<br>(*3) | — | — | — | — | — | — |

*1 TxPDO is not updated when SYNC0, which is the cause of the error such as Err80.7.0 “Synchronization signal error protection” , or interrupt processing omission by IRQ occurs.

*2 The expression “OP” appearing in the text of this document is an abbreviation for “operational”.

Note that this is not the ESM state transition OP (Operational → Pre-Operational).

*3 Bootstrap is not currently supported.

- Regardless of the table above, the ESC register can be accessed by the main device at any time.
- A communication error may occur if command updating stops before ESM state transition is completed during transition of the ESM state from OP to another ESM state (Init, PreOP, or SafeOP), or if there is a SYNC0 or SM2 event stoppage, etc.
- If repeatedly transitioning the ESM state, confirm that the previous status transition has been completed, and then transition to the next status.
- If Obj.3799h:00h “Communication function extended setup 6” :bit 0=0, the ESM state must be set to Init when using the Set-up Support Software (PANATERM ver.7) trial run, frequency characteristics analysis function (FFT function), etc. via USB communication.

  If Obj.3799h:00h “Communication function extended setup 6” :bit 0=1, Set-up Support Software (PANATERM ver.7) operations such as trial runs and frequency characteristics analysis functions (FFT function) are enabled even when the ESM state is not Init.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3799h | 00h | Communication function extended setup 6 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | B |
| ● bit 0: Enable/disable FFT execution while EtherCAT communication is established<br>0: Disabled<br>1: Enabled | | | | | | | | | | |

Please see *“6.6.1 Power Drive Systems (PDS) Status”* for a detailed description of PDS (Power Drive Systems).

### The relationship between each power drive system (PDS) status and ESM state

—: N/A

| PDS status | ESM state | | | | |
|---|---|---|---|---|---|
| | Init | PreOP | SafeOP | OP | Boot (*6) |
| Not ready to switch on | Yes | No | No | No | — |
| Switch on disabled | Yes | Yes | Yes | Yes | — |
| Ready to switch on (*1) | No | Yes | Yes | Yes | — |
| Switched on (*1) | No | Yes | Yes | Yes | — |
| Operation enabled (*2) (*5) | No | Yes (*4) | Yes (*4) | Yes | — |
| Fault reaction active | Yes | Yes | Yes | Yes | — |
| Fault (*3) | Yes | Yes | Yes | Yes | — |

*1 When a command to transition the ESM state from PreOP, SafeOP, or OP to Init is received, the ESM state is transitioned to “Switch on disabled”.

*2 When the PDS status is “Operation enabled”, and a command to transition the ESM state to another ESM state is received, there is a Err88.2.0 “ESM requirements during operation error protection” , and the PDS status is transitioned to Fault.

*3 The ESM state is retained when the PDS status has transitioned to Fault due to an error that is unrelated to EtherCAT communication. However, in case of a EtherCAT communication-related error, the ESM state follows the specifications set forth in *“10.2.3 Protection Function Details”* .

*4 Set the PDS status to “Operation enabled” in the ESM “OP” status.

*5 Status transitions in accordance with ESM requests from the main device may take time to reach completion.

Pay careful attention to timeout settings, etc., on the main device side.

For example, if the ESM state is transitioned from OP to PreOP when the PDS state is Operation enabled, Err88.2.0 “ESM requirements during operation error protection” will occur. After that, deceleration processing is performed according to Obj.605Eh:00h “Fault reaction option code” , but the ESM state during deceleration retains OP. Therefore, the slower the deceleration slope, the longer it takes to transition to PreOP.

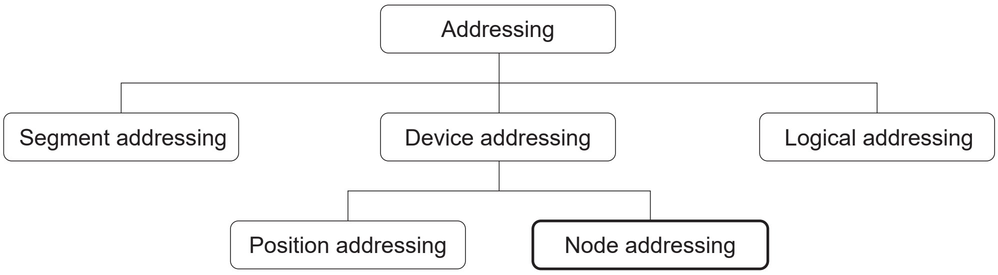
*6 PDS status is not supported when the ESM state is “Boot”.

Bootstrap is also not currently supported by this product.

## 4.2.5 Node Address

### 4.2.5.1 Node Address Setup Method

With this product, Node addressing specifies the unique node ID (station alias) for the main device to use in identifying a sub device.



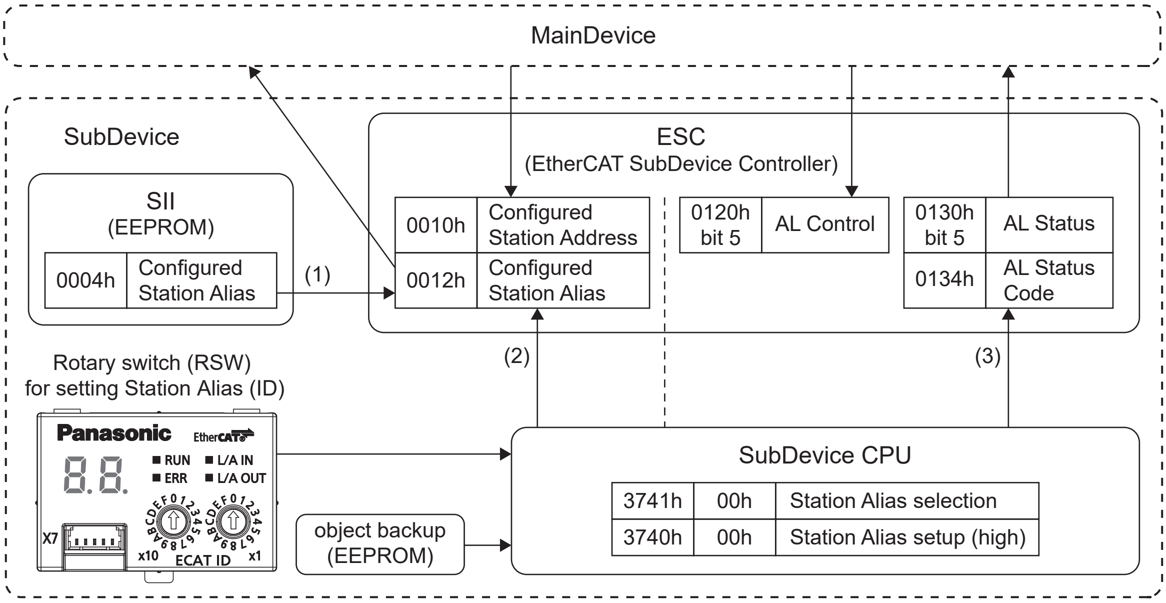
The product offers three methods of reading out address setup values. Use the address setting read method for the usage environment.

A rotary switch may be used depending on the address setup value read method.

Please see *“3.4.1 Operation and Display of the Front Panel”* for the rotary switch locations for this product.

The main device reads the value set in ESC register 0012h “Configured Station Alias” and sets that value to 0010h “Configured Station Address” .

This setting sets addresses for the FPRD commands etc. used by the mailbox.



| | |
|---|---|
| (1) | SII readouts via Configured Station Alias<br>This section describes how to read the value of SII.0004h “Configured Station Alias” from ESC register 0012h “Configured Station Alias” .<br>This product reads the Obj.3741h:00h “Station Alias selection” value from the backup EEPROM when the control power is turned on.<br>If the value read is 1, the value stored in SII.0004h “Configured Station Alias” is set to ESC register 0012h “Configured Station Alias” .<br>The main device should read this 0012h “Configured Station Alias” value and use it as the node address. |

| | |
|---|---|
| (2) | Rotary switch readout via Configured Station Alias<br>The method by which the value (lower 8 bits) set by the front panel rotary switch and the value (upper 8 bits) set by the Obj.3740h:00h “Station Alias setup (high)” is read from ESC register 0012h “Configured Station Alias” is explained below.<br>(Please see *“4.2.5.2 Station Alias”* for more information on selecting and setting Station Alias setup values with Obj.3740h:00h “Station Alias setup (high)” .)<br>This product reads the Obj.3741h:00h “Station Alias selection” value from the backup EEPROM when the control power is turned on.<br>If the read value read is 0, the value set by the rotary switch on the front panel and Obj.3740h:00h “Station Alias setup (high)” is set to 0012h “Configured Station Alias” in the ESC register.<br>The main device should read this 0012h “Configured Station Alias” value and use it as the node address. |

(3) Rotary switch value read via AL Status Code

The method by which the value (lower 8 bits) set by the front panel rotary switch and the value (upper 8 bits) set by the Obj.3740h:00h “Station Alias setup (high)” is read from 0134h “AL Status Code” is explained below.

(Please see *“4.2.5.2 Station Alias”* for more information on selecting and setting Station Alias setup values with Obj.3740h:00h “Station Alias setup (high)” .)

The value read using this method is not the value registered in 0012h “Configured Station Alias” of the ESC register.

The readout proceeds in the following order.

1 Set 0120h “AL Control” :bit 5 “ID Request” to 1.

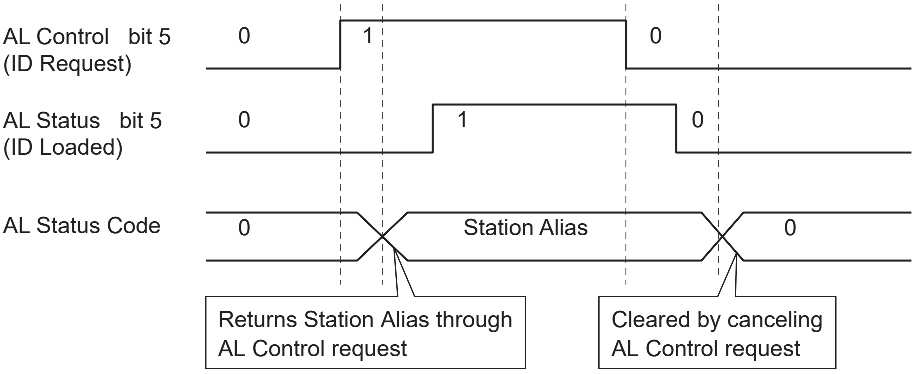
2 The station alias set by the rotary switch (lower 8 bits) and Obj.3740h (upper 8 bits) is returned to 0134h “AL Status Code” .

3 1 is returned to 0130h “AL Status” :bit 5 “ID Loaded”.

4 Set 0120h “AL Control” :bit 5 “ID Request” to 0.

5 0 is returned to 0130h “AL Status” :bit 5 “ID Loaded”.

6 0134h “AL Status Code” is cleared.

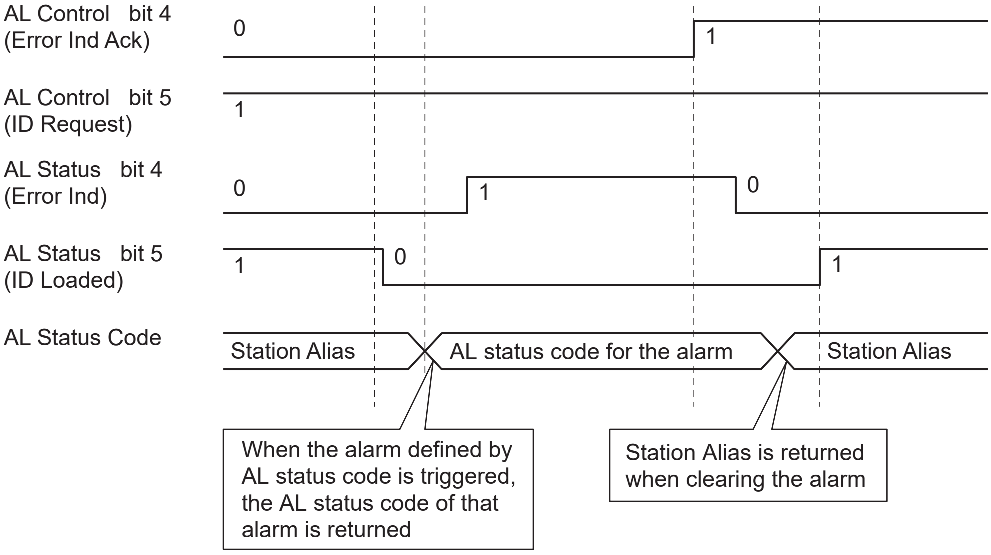


Station Alias: Value set by the rotary switch (lower 8 bits) and
Obj.3740h:00h “Station Alias setup (high)” (higher 8 bits)

Note that if there is an alarm defined in the AL status code (Err80.☐.☐, Err81.☐.☐, and Err85.☐.☐ among EtherCAT communication-related errors) is generated during the station alias reply, the AL status code for the alarm is returned.

When an alarm defined in the AL status code is cleared, it will once again return the Station Alias.

(Please see *“10.2 Protection Functions”* for how to clear the alarm)



### 4.2.5.2 Station Alias

Station Alias settings selection and address setting are performed by the following objects.

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>3740h</td><td>00h</td><td>Station Alias setup (high)</td><td>—</td><td>0 to 255</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>R</td></tr>
<tr><td></td><td colspan="10">● Sets the upper 8 bits of Station Alias.</td></tr>
<tr><td>3741h</td><td>00h</td><td>Station Alias selection</td><td>—</td><td>0 to 2</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>R</td></tr>
<tr><td></td><td colspan="10">● Specify the Station Alias setting method.<br>The initial value is 1.
<table>
<tr><th>Setup value</th><th>Function</th></tr>
<tr><td>0</td><td>The value (lower 8 bits) set by the front panel rotary switch and the value (upper 8 bits) set by the Obj.3740h:00h “Station Alias setup (high)” are set as the station alias.<br>When the setup value for both the rotary switch and the Obj.3740h:00h “Station Alias setup (high)” are 0, 0 is set as the station alias.<br>Note that the specifications are different from those for the MINAS A5B series.</td></tr>
<tr><td>1</td><td>SII.0004h value is set as the station alias.</td></tr>
<tr><td>2</td><td>Manufacturer use (setting is prohibited)</td></tr>
</table></td></tr>
</table>

When the Obj.3741h:00h “Station Alias selection” value is 0, a value that is the sum of the value (lower 8 bits) set by the front panel rotary switch and the value (upper 8 bits) set by the Obj.3740h:00h “Station Alias setup (high)” is set as the station alias.

| Station Alias | |
|---|---|
| Upper 8 bits | Lower 8 bits |
| 3740h setup value | Rotary switch setup value |

- Check *“3.4.2 Node Address”* concerning the front panel rotary switch setup value (lower 8 bits).

**— Precautions —**

- Each set value is enabled when the control power is turned on.

  Therefore, changes made after the control power is turned on are not reflected in the control, but become effective the next time the control power is turned on.

### 4.2.6 Communication Synchronous Mode

The product enables selection of the following synchronous modes.

| Synchronous mode | Description | Synchronization method | Characteristics |
|---|---|---|---|
| DC | SYNC0 event synchronization | The time information of another sub device is synchronized on the basis of the time on the first axis | • High precision<br>• Requires compensation processing on the main device side |
| SM2 | SM2 event synchronization | Synchronized with RxPDO reception timing | • Precision is poor without transmission delay correction<br>• Transmission timing must be constant on the main device side<br>(dedicated hardware, etc.) |
| FreeRun | Asynchronous | Asynchronous | • Processing is simple<br>• Lacks real-time properties |

Supported Mode Table

◎: Semi-closed and full-closed supported ○: Only semi-closed supported (*1) ×: Not supported

| Communication cycle [ms] | Synchronous mode | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DC | | | | | | | SM2 | | | | | | | FreeRUN | | | | | | |
| | pp | csp | hm | pv | csv | tq | cst | pp | csp | hm | pv | csv | tq | cst | pp | csp | hm | pv | csv | tq | cst |
| 0.0625 | × | ◎ | × | × | ○ | × | ○ | × | ◎ | × | × | ○ | × | ○ | × | × | × | × | × | × | × |
| 0.125 | × | ◎ | ◎ | × | ○ | × | ○ | × | ◎ | ◎ | × | ○ | × | ○ | × | × | ◎ | × | × | × | × |
| 0.250 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |
| 0.5 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |
| 1.0 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |
| 2.0 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |
| 4.0 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |
| 8.0 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |
| 10.0 | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | ◎ | ◎ | ○ | ○ | ○ | ○ | ◎ | × | ◎ | ○ | × | ○ | × |

*1 External scale position information monitor function for semi-closed control supported

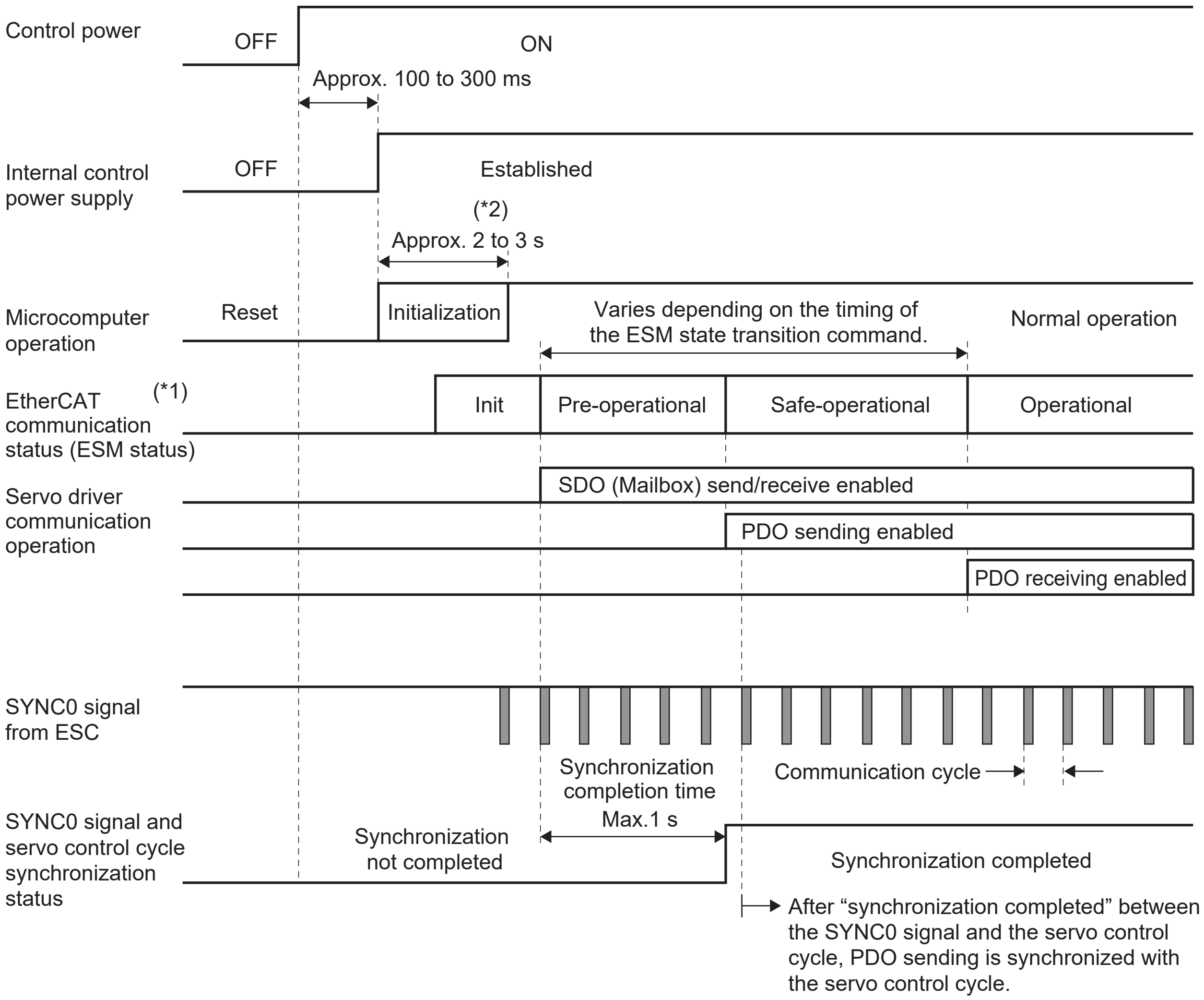
#### 4.2.6.1 DC (SYNC0 Event Synchronization)

The product is provided with a 64-bit Distributed Clock (DC). EtherCAT Communications are synchronized on the basis of this DC.

The sub device can be synchronized with the DC by sharing the same reference clock (System Time).

The sub device starts a local cycle in response to a synchronization event (SYNC0 event) that occurs in relation to the reference clock (System Time). Since sub device processing (servo processing) is started for the SYNC0 event, it is always synchronized with the SYNC0 event. Propagation delay compensation (offset compensation) must be performed when the main device undergoes communication initialization. Drift compensation must also be performed periodically.

**Flow chart from turning on control power to SYNC0 event and sub device processing (servo processing) synchronization completion**



*1 The ESM state in the figure above is the internal status of the product. Check on the main device side for transition completion between statuses.

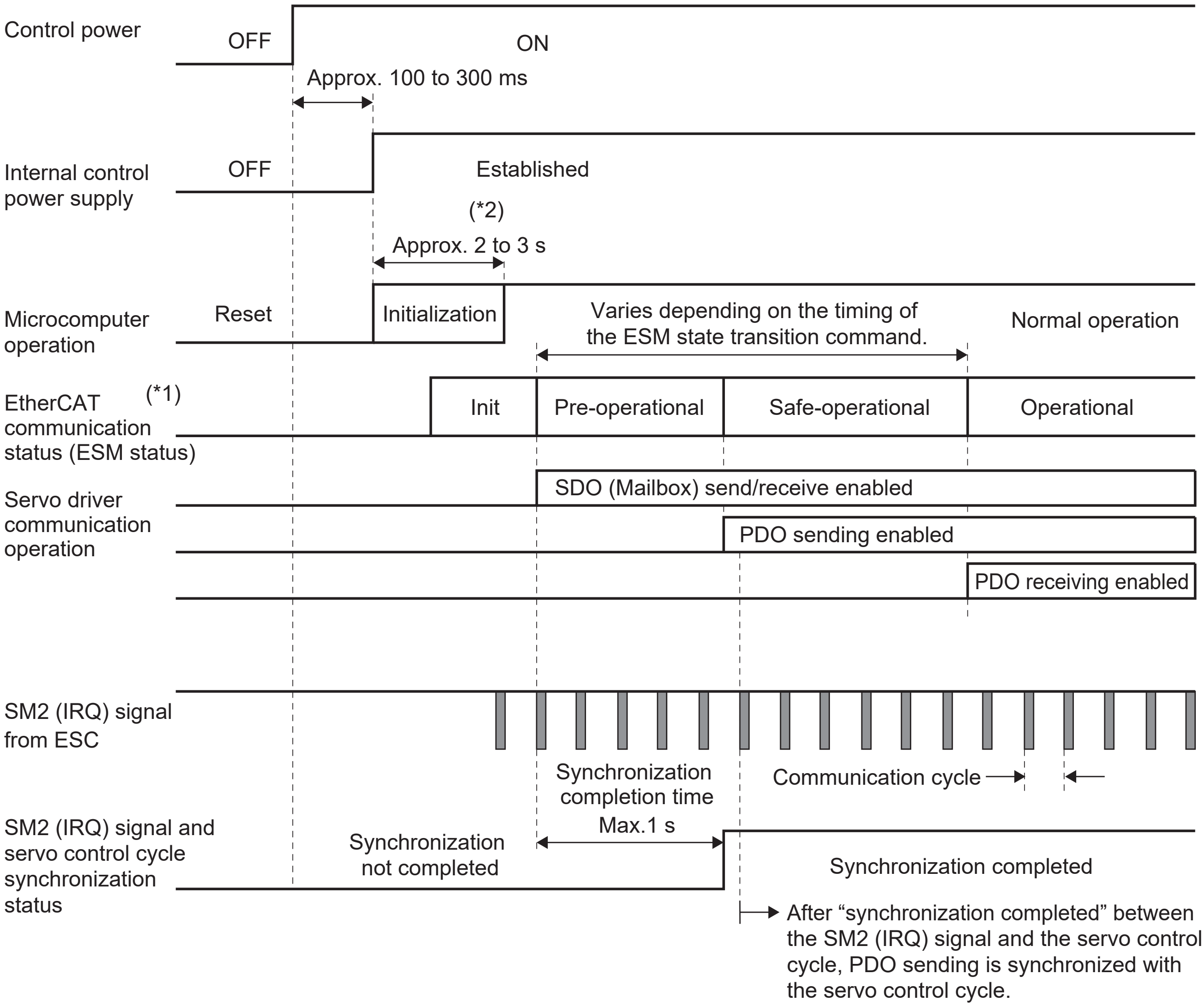
*2 Initialization time can be extended using Obj.3618h:00h "Power-up wait time" .

### 4.2.6.2 SM2 (SM2 Event Synchronization)

The sub device starts a local cycle corresponding to the RxPDO receive timing (SM2 event). Since sub device processing is started for the SM2 event, it is always synchronized with the SM2 event. However, since the SM2 event occurs upon completion of PDO reception, communication timing must be kept constant on the main device side.

If there is a large communication jitter (variation) in communication timing, synchronization is not completed, or an alarm is generated. If synchronization incompletion and/or alarm generation become problematic, use DC (SYNC0 event synchronization).

**Flow chart from turning on control power to SM2 event and sub device processing (servo processing) synchronization completion**



*1 The ESM state in the figure above is the internal status of the product. Check on the main device side for transition completion between statuses.

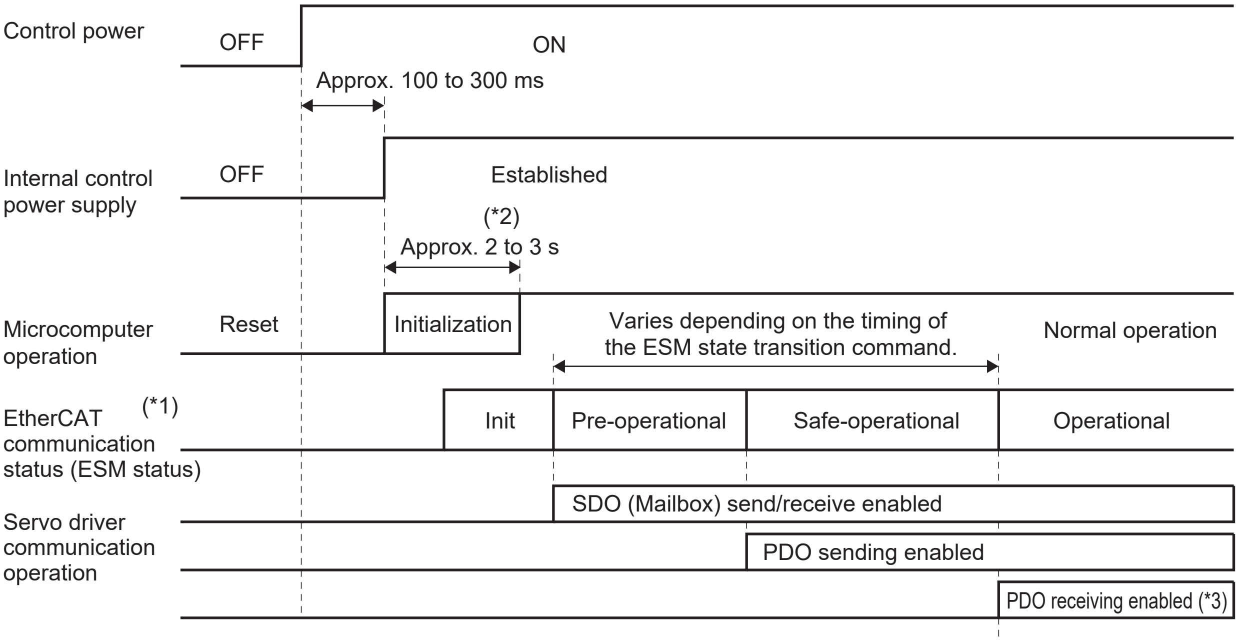
*2 Initialization time can be extended using Obj.3618h:00h “Power-up wait time” .

### 4.2.6.3 FreeRun (Asynchronous)

A local cycle is started by the local timer interrupt of a sub device.

The local cycle is asynchronous to the communication cycle and the main device cycle, and operates independently.

**Flow chart for when control power is turned on**



*1 The ESM state in the figure above is the internal status of the product. Check on the main device side for transition completion between statuses.

*2 Initialization time can be extended using Obj.3618h:00h “Power-up wait time” .

### 4.2.7 SDO (Service Data Object)

The product supports SDO (Service Data Object). Mailbox communication is used for SDO data exchange. Note that the timing of SDO data updates is indeterminate.

Object settings and various sub device statuses can be monitored by reading and writing data in entries in the object dictionary on the main device side.

**— Precautions —**

- Response by the SDO to the read/write operation may take time.
- Do not update, using an SDO, objects that have been updated by a PDO.

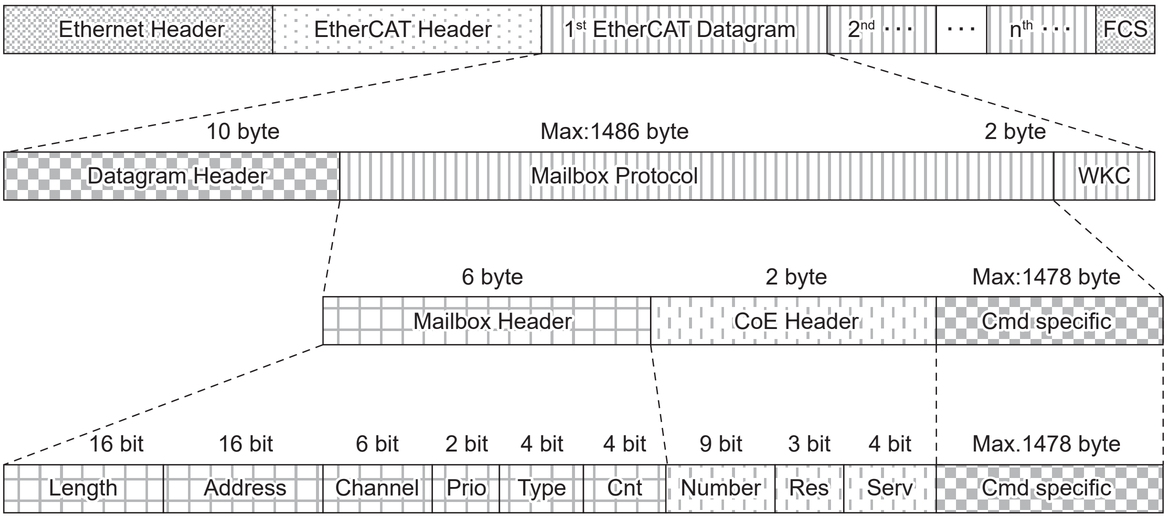
  They will be overwritten with PDO values. Please see *“4.2.8 PDO (Process Data Object)”* for a detailed description of PDO.

#### 4.2.7.1 Mailbox Frame Configuration

The Mailbox/SDO frame configuration is as follows.

For details, see ETG standards ETG.1000.5 and ETG.1000.6 in *"1.4.3 EtherCAT Reference Documents"* : *"EtherCAT standards"* .

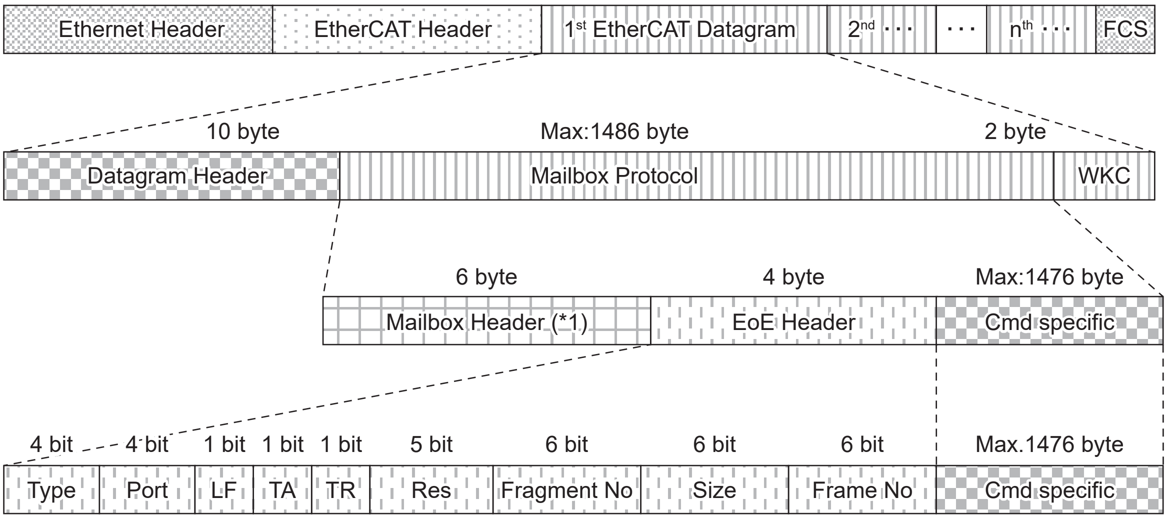
### ■ CoE scenario



| Frame section | Data field | Data type | Function |
|---|---|---|---|
| Mailbox Header | Length | WORD | Mailbox data length |
| | Address | WORD | Originating station address |
| | Channel | Unsigned6 | (Reserved) |
| | Priority | Unsigned2 | Priority |
| | Type | Unsigned4 | Mailbox type<br>00h: Error<br>01h: (Reserved)<br>02h: EoE (not supported)<br>03h: CoE<br>04h: FoE (not supported)<br>05h: SoE (not supported)<br>06h to 0Eh: (Reserved)<br>0Fh: VoE (not supported) |
| | Cnt | Unsigned3 | Mailbox counter |
| | Reserved | Unsigned1 | (Reserved) |
| CoE Header | Number | Unsigned9 | (Reserved) |
| | Reserved | Unsigned3 | (Reserved) |
| | Service | Unsigned4 | Message type |
| Cmd specific | Size Indicator | Unsigned1 | Data set size licensed |
| | Transfer Type | Unsigned1 | Normal transmission, expedited transmission selection |
| | Data Set Size | Unsigned2 | Data size specification |
| | Complete Access | Unsigned1 | Object access method selection<br>(Not supported) |
| | Command Specifier | Unsigned3 | Upload, download requests, responses, etc. - selection |
| | Index | WORD | Object index |

| Frame section | Data field | Data type | Function |
|---|---|---|---|
| Cmd specific | Subindex | BYTE | Object sub-index |
| | □□□ | □□□ | Object data or abort message, etc.<br>Functions are altered by combining the following data fields.<br>● Size Indicator<br>● Transfer Type<br>● Data Set Size<br>● Complete Access<br>● Command Specifier |

## ■ EoE scenario



*1 The Mailbox Header is shared with the CoE frame configuration.

| Frame section | Data field | Data type | Function |
|---|---|---|---|
| EoE Header | FrameType | Unsigned4 | EoE Service Type |
| | Port | Unsigned4 | Designation of specific ports |
| | Last Fragment | Unsinged1 | Last Fragment Identifier |
| | Time Appended | Unsinged1 | Last Fragment Timestamp Availability |
| | Time Request | Unsinged1 | Timestamp Request |
| | Reserved | Unsinged5 | (Reserved) |
| | Fragment Number | Unsinged6 | Fragment Number |
| | Frame Number | Unsinged4 | Frame Number |
| Cmd specific | Complete Size | Unsinged6 | Frame Length |
| | EoE Data | BYTE[N-4] | EoE Data<br>(excluding preamble, SFD, FCS, and timestamp) |
| | TimeStamp | Unsigned32 | Frame Receive Time |
| | Offset | Unsigned6 | Offset of 32 octet block of Ethernet frame fragment |

### 4.2.7.2 Mailbox Timeout

The product sets the following timeout times for mailbox communication.

- Mailbox request timeout time: 100 ms

  The main device transmits a request to a sub device (driver), and the sub device regards the request as normally received if the request frame transmitted data working counter (WKC) has been updated. The request is repeated until the WKC is updated, but there is a timeout on the main device side if the WKC is not updated by the setting time there.

- Mailbox request timeout time: 10 s

  The main device receives from the sub device (driver) a response to the request, and regards the response as normally received if the WKC has been updated. There is a timeout on the main device side if a response for which the WKC has been updated cannot be received by the setting time there.

  The Mailbox request timeout time is the maximum time required by the sub device (driver) for the response operation.

### 4.2.7.3 Message When an Error Occurs

#### 4.2.7.3.1 Abort Messages

If SDO data exchange processing (read/write) fails, an error message that includes an Abort code called an Abort message is returned. The Abort message is an error process that occurs only in SDO data exchange processing; there are no Abort messages in PDO data exchange processing.

The Abort code details may vary, depending on access conditions.

| Abort code | Description | | This product |
|---|---|---|---|
| 05030000h | Toggle bit not changed | Toggle bit not changed | Not supported |
| 05040000h | SDO protocol timeout | SDO protocol timeout | Not supported |
| 05040001h | Client and server command specifiers not valid or unknown | Client and server command specifiers not valid or unknown | Supported |
| 05040005h | Out of memory | Out of memory | Not supported |
| 06010000h | Unsupported access to an object | Unsupported access to an object | Supported |
| 06010001h | Attempt to read to a write only object | Attempt to read to a write only object | Not supported |
| 06010002h | Attempt to write to a read only object | Attempt to write to a read-only object | Supported |
| 06010003h | Subindex cannot be written, SI0 must be 0 for write access | Sub-index cannot be written<br>Sub-index 00h must be set to 0 for write access | Supported |
| 06020000h | The object does not exist in the object directory | The object does not exist in the object directory | Supported |
| 06040041h | The object cannot be mapped into the PDO | The object cannot be mapped into the PDO | Not supported |
| 06040042h | The number and length of the objects to be mapped would exceed the PDO length | The number and length of the objects to be mapped would exceed the PDO length | Not supported |
| 06040043h | General parameter incompatibility reason | General parameter incompatibility | Not supported |
| 06040047h | General internal incompatibility in the device | General internal incompatibility in the device | Not supported |
| 06060000h | Access failed due to a hardware error | Access failed due to a hardware error | Supported |
| 06070010h | Data type does not match, length of service parameter does not match | Data type does not match, length of service parameter does not match | Supported |
| 06070012h | Data type does not match, length of service parameter too high | Data type does not match, length of service parameter too long | Not supported |
| 06070013h | Data type does not match, length of service parameter too low | Data type does not match, length of service parameter too short | Not supported |

| Abort code | Description | | This product |
|---|---|---|---|
| 06090011h | Subindex does not exist | Subindex does not exist | Supported |
| 06090030h | Value range of parameter exceeded (only for write access) | Value range of parameter exceeded (only for write access) | Supported |
| 06090031h | Value of parameter written too high | Value of parameter written too high | Supported |
| 06090032h | Value of parameter written too low | Value of parameter written too low | Supported |
| 06090036h | Maximum value is less than minimum value | Maximum value is less than minimum value | Supported |
| 08000000h | General error | General error | Not supported |
| 08000020h | Data cannot be transferred to or stored in the application | Data cannot be transferred to or stored in the application | Supported |
| 08000021h | Data cannot be transferred to or stored in the application because of local control | Data cannot be transferred to or stored in the application because of local control | Not supported |
| 08000022h | Data cannot be transferred to or stored in the application because of the present device status | Data cannot be transferred to or stored in the application because of the present device status | Supported |
| 08000023h | Object dictionary dynamic generation fails or no object dictionary is present | No object dictionary exists | Supported |

#### 4.2.7.3.2 Emergency Messages

The main device is notified of emergency messages by the sub device via Mailbox communication when there is an error (alarm) in the product (sub device). There is no notification when there has only been a warning, without an error (alarm) occurring.

Up to eight emergency messages generated when the ESM state is “Init” are buffered in the order generated, and returned all at once when the ESM state has transitioned from Init → PreOP or beyond. However, any more than eight are discarded sequentially from that generated first.

Enable or disable emergency message transmission by setting Obj.10F3h:05h “Diagnosis history:Flags” :bit 0.

The default for emergency message transmission is “enabled” (Obj.10F3h:05h “Flags” :bit 0=1).

See *“6.3.6 Diagnosis history (Error (Alarm) History Readout Function) (10F3h)”* for Sub-Indexes other than Obj.10F3h:05h “Diagnosis history:Flags”.

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 10F3h | – | Diagnosis history | – | – | – | – | – | – | – | – |
| | ● Settings are executed to enable or disable error history readouts and emergency messages. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 10F3h | 05h | Flags | — | 0 to 65535 | U16 | See below table | No | ALL | Yes | A |

| | | |
|---|---|---|
| bit 0 | rw | Emergency message execution permission<br>0: Emergency messages disabled<br>1: An Emergency message is issued for each new error detected (may not be left in a Diagnosis message, depending on the error) |
| bit 1 | r | Not supported: 1 fixed |
| bit 2 | r | Not supported: 1 fixed |
| bit 3 | r | Not supported: 0 fixed |
| bit 4 | r | Not supported: 0 fixed |
| bit 5 | r | Diagnosis message clearing information<br>0: There is error history information<br>1: There is no error history information, or error history information clearing (when writing Obj.10F3h:03h=0) has been completed (will be retained until the next error/alarm is generated) |
| bits 15 to 6 | — | Reserved |

**— Precautions —**

- If multiple errors (alarms) occur and are cleared in a short period of time, the Emergency message as to the final status may be the only notification.

The Emergency message comprises 8 bytes of data, as shown below.

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Description | *“Error code”*<br>(L) | (H) | *“Error register”* | *“Error Field”* | | | | |

## ■ Error code

The same values are returned for the error code as in Obj.603Fh:00h “Error code” .

0000h to FEFFh are defined as per CiA402 Standard IEC61800-7-201.

FF00h to FFFFh can be uniquely defined by the manufacturer. The details are as follows.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- An alarm (main number only) and/or warning generated by the product are displayed.
  When no alarm or warning is generated, 0000h is displayed.
  When an alarm and a warning are generated simultaneously, the alarm is displayed.
  The alarm and warning are displayed in “FF**h” format.
  The following numbers are displayed in the “**” segment.
  - Alarm (main) numbers (00h to 9Fh)
  - Warning numbers (A0h to A9h, ABh, E1h to E2h, C3h, CAh, D2h)

(Example)

FF0Ch (0Ch=12d): Err12.0.0 “Overvoltage protection” occurs

FF55h (55h=85d): Either Err85.0.0 “TxPDO assignment error protection” or Err85.1.0 “RxPDO assignment error protection” occurs

**Notes**

- In exceptional cases of Err81.7.0 “SyncManager 2 / 3 setup error protection” , A000h is displayed.
- The timing of alarm number setting for Obj.603Fh:00h “Error code” is the same as for emergency messages. For this reason, the value is set later than for Obj.6041h:00h “Statusword” :bit 3 “fault” .

## ■ Error register

The same values as Obj.1001h:00h “Error register” are returned in the error register.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1001h | 00h | Error register | — | 0 to 255 | U8 | ro | No | ALL | No | X |

- The alarm type (status) generated by the product is displayed.
  When no alarm is generated, 0000h is displayed.
  No warning is displayed.

| bit | Description |
|---|---|
| 0 | (Not supported) |
| 1 | |
| 2 | |
| 3 | |
| 4 | Generation of an alarm defined by AL status code (*1) |
| 5 | (Not supported) |
| 6 | (reserved) |
| 7 | Generation of an alarm not defined by AL status code (*2) |

*1 “An alarm defined by AL status code” denotes Err80.0.0 to Err80.4.0, Err80.6.0 to Err80.7.0, Err81.☐.☐, Err85.0.0 to Err85.1.0, and Err85.3.0 among EtherCAT communication-related errors.

*2 “An alarm undefined by AL status code” denotes an error other than that which is EtherCAT communication-related or Err85.2.0 or Err88.☐.☐ among EtherCAT communication-related errors.

Please see *“10.2 Protection Functions”* for a detailed description of alarms.

## ■ Error Field

Data [0] to [4] are assigned to the Error Field, which returns the alarm sub-number and primary cause number.

The main number of the alarm is indicated by the Error Code. Please see *“Error code”* in this chapter for a detailed description of Error Codes.

- When an error other than Err81.7.0 “SyncManager 2 / 3 setup error protection” occurs with this product

  Alarm sub-number is returned to Data [0].

  Alarm cause number is returned to Data [1].

  00h is returned to Data [2] to [4].

(Example) When Err16.1.0 “Torque saturation error protection” occurs

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Description | Error code | | Error register | Data [0] | Data [1] | Data [2] | Data [3] | Data [4] |
| Value | FF10h | | 80h | 01h | 00h | 00h | 00h | 00h |

- When an error status is cleared for this product

  Data [0] to [4] are cleared to 00h.

(Example) When the alarm status is cleared by Fault reset

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Description | Error code | | Error register | Data [0] | Data [1] | Data [2] | Data [3] | Data [4] |
| Value | 0000h | | 00h | 00h | 00h | 00h | 00h | 00h |

- When Err81.7.0 “SyncManager 2 / 3 setup error protection” occurs during PreOP→SafeOP due to incorrect SyncManager2 and SyncManager3 settings

  The error code is set to A000h, the error register is set to 10h, and specified data is returned. For details, see ETG standard ETG.1000.6 in *“1.4.3 EtherCAT Reference Documents”* : *“EtherCAT standards”* .

  (Example) When SyncManager2 and SyncManager3 settings are incorrect

1. When the SyncManager2 Length (ESC register: 0812h, 0813h) setting is invalid (*1)
2. When the SyncManager2 physical start address (ESC registers 0810h and 0811h) settings are incorrect (i.e., set outside the range of 1000h to 2FFEh, or to an odd number, etc.)
3. When SyncManager2 settings are incorrect (set to deactivated and 1-buffer, set to Read, etc.)
4. When the SyncManager3 Length (ESC register: 081Ah, 081Bh) setting is invalid (*1)
5. When the SyncManager3 physical start address (ESC registers 0818h and 0819h) settings are incorrect (set outside the range of 1000h to 2FFEh, or to an odd number, etc.)
6. When SyncManager3 settings are incorrect (i.e., set to deactivated and 1-buffer, set to Write, etc.)

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Description | Error code | | Error register | Data [0] | Data [1] | Data [2] | Data [3] | Data [4] |
| “1” | A000h | | 10h | 08h | (L) Length (*2) (H) | | (L) Length (*2) (H) | |
| “2” | A000h | | 10h | 09h | 00h | 10h | FEh | 2Fh |
| “3” | A000h | | 10h | 0Ah | 24h (*3) | 00h (*3) | 01h (*3) | 00h (*3) |
| “4” | A000h | | 10h | 0Ch | (L) Length (*2) (H) | | (L) Length (*2) (H) | |
| “5” | A000h | | 10h | 0Dh | 00h | 10h | FEh | 2Fh |
| “6” | A000h | | 10h | 0Eh | 20h (*3) | 00h (*3) | 01h (*3) | 00h (*3) |

*1 Returned if different from the PDO mapping size, etc. However, Err85.1.0 “RxPDO assignment error protection” will occur if the PDO mapping size exceeds 32 bytes. 01h (the alarm sub-number) is returned to Data [0], 00h (the alarm primary cause number) is returned to Data [1], and 00h is returned to Data [2] to [4].

*2 The value of the PDO mapping size actually set for length is returned.

If, for example, the PDO mapping size is 9, Data [1] = 09h, Data [2] = 00h, Data [3] = 09h, and Data [4] = 00h are respectively returned.

*3 If the PDO mapping size is 0, 00h is returned to Data [1] to [4].

### 4.2.8 PDO (Process Data Object)

The product supports PDO (Process Data Object).

EtherCAT performs real-time data transfer via PDO exchange. PDOs include RxPDO, which is transferred from main device to sub device, and TxPDO, which is transferred from sub device to main device.

| | Sending side | Receiving side |
|---|---|---|
| RxPDO | Main Device | Sub Device |
| TxPDO | Sub Device | Main Device |

**— Precautions —**

- Do not update, using an SDO, objects that have been updated by a PDO. They will be overwritten with PDO values.

  Please see *“4.2.7 SDO (Service Data Object)”* for a detailed description of SDO.

### 4.2.8.1 PDO Mapping Object

PDO mapping is the process of selecting the required objects from the object dictionary and assigning them as PDO data.

*“Setting example”* , described below, is an example of assigning a given object (Obj.6040h:00h and another 4 items) to a PDO mapping object (Obj.1600h) for reception.

In the product, mapping objects in Obj.1600h to Obj.1603h can be used as tables for PDO mapping for the RxPDO, and Obj.1A00h to Obj.1A03h can be used for the TxPDO.

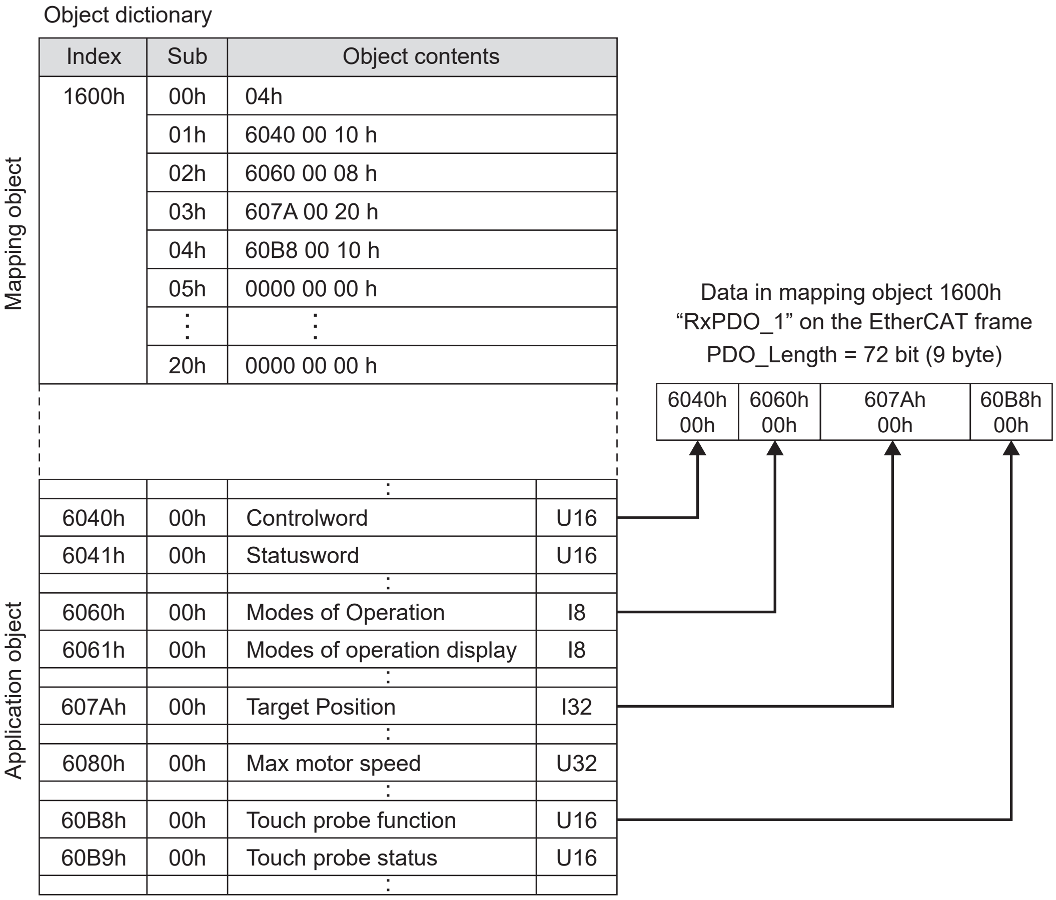
The maximum numbers for application objects mappable in a single mapping object are as follows.

| | |
|---|---|
| Maximum data length | RxPDO: 32 bytes<br>TxPDO: 32 bytes |

A PDO mapping setup example is shown below. Please see *“6.3.3 Process Data Object (PDO) Mapping”* for a detailed description of setup methods.

#### ■ Setting example

The following figure shows the settings for assigning application objects Obj.6040h:00h “Controlword” , Obj.6060h:00h “Modes of operation” , Obj.607Ah:00h “Target position” , and Obj.60B8h:00h “Touch probe function” to the mapping object Obj.1600h: “Receive PDO mapping 1” : “RxPDO_1”.



| Index | Sub | Object contents |
|---|---|---|
| 1600h | 00h | 04h |
| | 01h | 6040 00 10 h |
| | 02h | 6060 00 08 h |
| | 03h | 607A 00 20 h |
| | 04h | 60B8 00 10 h |
| | 05h | 0000 00 00 h |
| | ⋮ | ⋮ |
| | 20h | 0000 00 00 h |

| | | | |
|---|---|---|---|
| | | : | |
| 6040h | 00h | Controlword | U16 |
| 6041h | 00h | Statusword | U16 |
| | | : | |
| 6060h | 00h | Modes of Operation | I8 |
| 6061h | 00h | Modes of operation display | I8 |
| | | : | |
| 607Ah | 00h | Target Position | I32 |
| | | : | |
| 6080h | 00h | Max motor speed | U32 |
| | | : | |
| 60B8h | 00h | Touch probe function | U16 |
| 60B9h | 00h | Touch probe status | U16 |
| | | : | |

| | | | |
|---|---|---|---|
| 6040h<br>00h | 6060h<br>00h | 607Ah<br>00h | 60B8h<br>00h |

### 4.2.8.2 PDO Assign Object

PDO Assign assigns a table for PDO mapping to the SyncManager in order to exchange PDO data.

The relation between the table for PDO mapping and the SyncManager is written to the SyncManager PDO Assign object.

In the product, Obj.1C12h: “Sync manager channel 2” can be used for RxPDO (SyncManager 2), and Obj.1C13h: “Sync manager channel 3” for TxPDO (SyncManager 3), as a PDO Assign object.

The maximum numbers of mapping objects that can be assigned to a single Assign object are as follows.

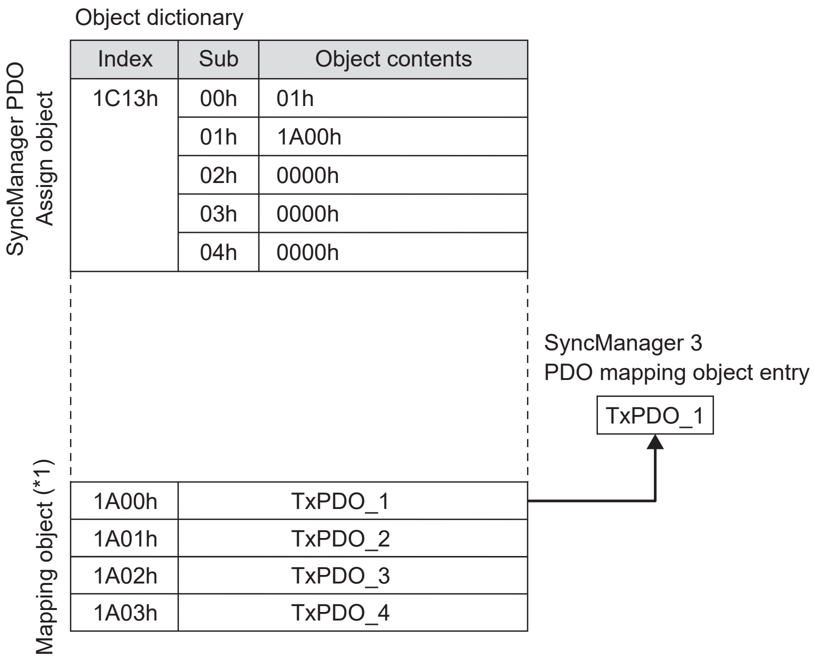
| | |
|---|---|
| Maximum number of PDO assignments | RxPDO: 4 Table<br>TxPDO: 4 Table |

Since one mapping object is usually sufficient, there is no need to make a change from the default.

A SyncManager PDO Assign object setting example is shown below. Please see *“6.3.3 Process Data Object (PDO) Mapping”* for a detailed description of setup methods.

#### ■ Setting example

The following figure shows the settings for assigning mapping object Obj.1A00h: “Transmit PDO mapping 1” to assign object Obj.1C13h: “Sync manager channel 3” .



Object dictionary

| Index | Sub | Object contents |
|---|---|---|
| 1C13h | 00h | 01h |
| | 01h | 1A00h |
| | 02h | 0000h |
| | 03h | 0000h |
| | 04h | 0000h |

| | |
|---|---|
| 1A00h | TxPDO_1 |
| 1A01h | TxPDO_2 |
| 1A02h | TxPDO_3 |
| 1A03h | TxPDO_4 |

*1 Please see *“6.3.3.3 Default PDO Mapping”* for a detailed description of mapping object factory default values.

## 4.2.9 Ethernet over EtherCAT (EoE) Function

### 4.2.9.1 EoE Function

The product supports EoE functionality. EoE is a function that allows Ethernet frames to be transmitted (EoE communication) between the main device and a sub device in the EtherCAT segment by encapsulating the Ethernet packet in a EtherCAT Mailbox packet.

Mailbox communication is used for EoE communication.

EoE communication uses the virtual Ethernet switch function of the host device. Refer to the operating instructions for the host device for how to use the virtual Ethernet switch function.

This function allows a PC on which Set-up Support Software (PANATERM ver.7) is installed to be connected to the product via the EtherCAT communication cable and issue operation commands via EtherCAT communication, which were previously issued via USB communication.

This product supports the following protocols in the TCP/IP stack.

- IPv4 (Internet Protocol version 4) *Only non-fragmented packets are supported
- ARP (Address Resolution Protocol)
- ICMP (Internet Control Message Protocol)
  *Only Echo Request Message receipt and Echo Reply Message sending is supported
- UDP (User Datagram Protocol)
- TCP (Transmission Control Protocol)

For configuration settings of the main device when using the EoE function, see *“12.1.2.2.1 Network Settings for EoE Communication”* .

Related objects

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D16h | — | EoE information display | — | — | — | — | — | — | — | — |
| | ● Displays EoE configuration information. | | | | | | | | | |
| 4D16h | 00h | Number of entries | — | 0 to 255 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of Obj.4D16h: “EoE information display” Sub-Indexes. | | | | | | | | | |
| 4D16h | 01h | Virtual MAC address | — | — | VS | ro | No | ALL | No | X |
| | ● Displays the virtual MAC address (17 bytes) set for the sub device.<br>(Example) “02:01:05:30:03:e9”<br>18 to 22 bytes are NULL.<br>Values after 23 bytes are undefined.<br>The size of this object is 44 bytes including undefined values. | | | | | | | | | |
| 4D16h | 02h | IP address | — | — | VS | ro | No | ALL | No | X |
| | ● Displays the IP address (max. 15 bytes) set for the sub device.<br>(Example) “192.168.1.2”<br>The IP address is followed by 1 byte of NULL.<br>The values after the next data after NULL are undefined.<br>The size of this object is 36 bytes including undefined values. | | | | | | | | | |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4D16h</td><td>03h</td><td>Subnet mask</td><td>–</td><td>–</td><td>VS</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the subnet mask (max. 15 bytes) set for the sub device.<br>(Example) “255.255.255.0”<br>The subnet mask is followed by 1 byte of NULL.<br>The values after the next data after NULL are undefined.<br>The size of this object is 36 bytes including undefined values.</td></tr>
<tr><td>4D16h</td><td>04h</td><td>Default Gateway</td><td>–</td><td>–</td><td>VS</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the default gateway (max.15 bytes) configured for the sub device.<br>(Example) “172.16.8.12”<br>The default gateway is followed by 1 byte of NULL.<br>The values after the next data after NULL are undefined.<br>The size of this object is 36 bytes including undefined values.</td></tr>
</table>

**— Precautions —**

- The EoE function cannot be used in connection with a main device that does not have the virtual Ethernet switch function.
- Set the network settings for EoE communication to this product to a fixed IP address.
- This product requires the sub device to be rebooted when disabling an already-enabled EoE function. Therefore, if EoE communication will not be used, do not enable the EoE function on the sub device side. If you want to communicate without using the EoE function while the EoE function is still enabled on the sub device side, disable the virtual Ethernet switch function on the main device.
- Depending on network load conditions and other factors, operations via EoE communication may not be immediately reflected. Therefore, when extending the trial run timeout time, make sure that the main power supply can be immediately shut off when executing the trial run operation.
- When Set-up Support Software (PANATERM ver.7) is connected via EoE communication, it is not possible to write objects in the object editor.

  To write objects in the object editor, connect Set-up Support Software (PANATERM ver.7) via USB communication. Or, instead of using Set-up Support Software (PANATERM ver.7) , write the object from the main device via CoE communication.

### 4.2.9.2 “PANATERM ver.7” Set-up Support Software Connection Procedures

To connect a sub device to Set-up Support Software (PANATERM ver.7) via EoE communication, the IP address of the sub device to be connected must be specified on Set-up Support Software (PANATERM ver.7) and the sub device must be selected.

The network settings of the main device and sub device must be completed before configuring the procedure parameters described in this section. See *“12.1.2.2.1 Network Settings for EoE Communication”* for a detailed description of network settings.

The following procedure is used to connect a Set-up Support Software (PANATERM ver.7) to a sub device.

1 After Set-up Support Software (PANATERM ver.7) startup, select “Connection with driver (EoE Communication)” and click “Network Settings” to display the pop-up menu.

2 In the “Network Settings” pop-up menu, input the IP address of the sub device set in the main device, then click OK to close the pop-up menu.

3 Shortly after closing the “Network Settings” pop-up menu a list of connected sub devices will appear on the screen.

Select the sub device to be connected to Set-up Support Software (PANATERM ver.7) and click “OK” to begin EoE communication with the sub device.

# 5 Trial Run

## 5.1 Trial Run Flow

First check the operation of the servo driver in a trial run.

The procedure of the trial run is as follows.

### 5.1.1 Preparation

1 Installation

Install the servo driver and motor properly.

2 Wiring

Wire the servo driver, motor and host device.

**— Precautions —**

- Because the trial run is performed without load, do not connect the motor to the mechanical system.

3 Confirmation before trial run

Check *“5.2 Confirmation Before Trial Run”* before conducting the trial run.

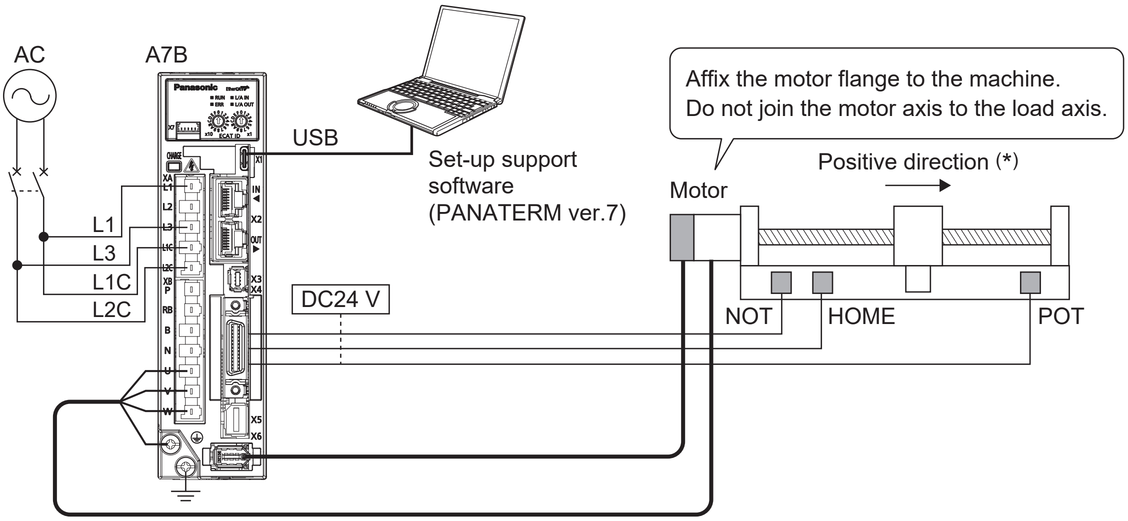
### 5.1.2 Trial Run

1 Trial run using the motor unit

Check the operation of the motor unit using the trial run function of Set-up Support Software (PANATERM ver.7) on the PC connected to the servo driver. Check the operation of the servo driver and motor before operating using EtherCATcommunication from the host device. For detailed steps, check *“5.3 Trial Run Using the Motor Unit”* .

In the future, this product will support the EoE (Ethernet over EtherCAT) function described below. After this function is implemented, communication will be possible with a PC on which Set-up Support Software (PANATERM ver.7) is installed via EtherCAT connection in addition to conventional USB connection. For details of the EoE function, see *“4.2.9 Ethernet over EtherCAT (EoE) Function”* .

The following shows an example of when the servo driver is connected to the PC via USB.



* Whether CCW or CW is the positive direction is set by Obj.607Eh:00h “Polarity” .

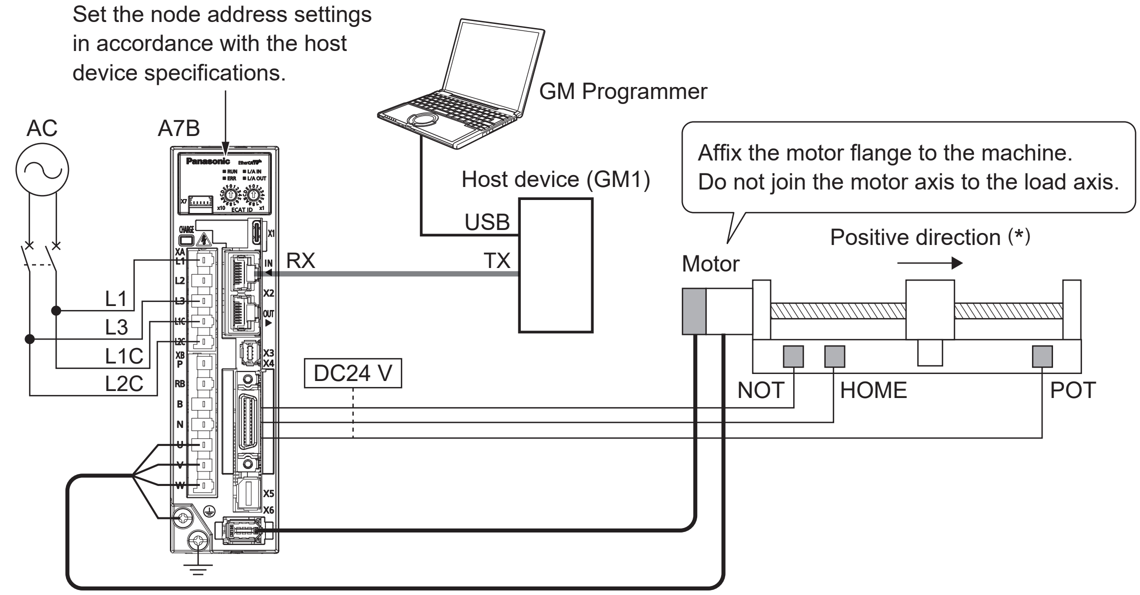
2 Trial run via EtherCAT communication

Connect the host device to the servo driver and perform an operation check via EtherCAT communication from the host device side.

After checking operation with a trial run using the motor unit, confirm operation via EtherCAT communication.

In this method described in this chapter, the trial run is carried out using a Panasonic motion controller GM1 as the host device and the application GM Programmer on the PC to control the host device GM1.Check *"5.4 Trial Run via EtherCAT Communication"* .

The following figure shows an example of a USB connection between GM1 and the GM Programmer on the PC.



* Whether CCW or CW is the positive direction is set by Obj.607Eh:00h "Polarity" .

## 5.2 Confirmation Before Trial Run

To run a trial run safely and properly, check the installation status and wiring as follows before running the trial.

1 Installation

Confirm proper installation of the servo driver and motor to prevent accidents and damage to the servo driver and motor, referring to *"3.1 Installation"* .

2 Wiring

Referring to *"3.2 Connections"* , check the following items regarding the wiring of the servo driver, motor, and host device.

- Is the power supply connected to the power supply input terminal?
- Is the earth wire connected to the earth terminal?
- Do the motor connection terminal and the motor phase match?
- Have the power supply input terminal and motor connection terminal not shorted?
- Is the motor earth connected to the servo driver earth terminal?
- Are the terminal parts loose?
- Is excessive force being exerted on the wires or cables, or are they being pulled?
- Does the voltage applied to the I/O connector X4 not exceed 24 V DC?
- Is a device such as a host device connected to the pins of I/O connector X4 and is a signal input to the POT (SI2) and NOT (SI3) terminals?

  If not input, see as there are other methods besides signal input.
- Has the short wire been removed when using an external regenerative resistor?

3 Power supply

Referring to *"2.1.4 Specifications"* , check that the input power supply voltage is within the specified range in line with the specifications.

4 Servo driver

Check to make sure that the screws in the fastening section of the terminal block are not loose.

5 Motor

- Check that the motor mount and axis coupling are not loose.

**— Precautions —**

- The description in this document assumes that the trial run is carried out in a no-load environment with the motor not connected to the mechanical system.
- If the motor is connected to the mechanical system, check that incorporated equipment is operating properly.

## 5.3 Trial Run Using the Motor Unit

Operation can be confirmed using the motor unit without connecting the host device to the servo driver.

Operation of a trial run using Set-up Support Software (PANATERM ver.7) on the PC is described here.

Although JOG operation, STEP operation, and Z-phase search can be performed with trial run, this section describes JOG operation. See Set-up Support Software (PANATERM ver.7) Operating Manual for STEP and Z-phase search operation.

- In JOG operation, the motor can be rotated in the positive (+ direction) or negative (- direction) direction at the touch of a button.
- In STEP operation, the amount of movement and operation pattern can be set, and the motor can be operated according to the setting.
- Z-phase search allows the motor to rotate to the position where the Z-phase output turns on.

When connecting the host device, ensure that the host device power is off.

Implement the trial run without connecting the EtherCAT communication cable.

### 5.3.1 Items to Check Before Running the Trial

Ensure that the following items are checked before conducting the trial run.

- The main circuit power supply is ON.
- An alarm is not occurring.
- The status is at servo-off.
- Be ready to shut off power immediately in case of hazards such as unexpected operation of the motor.

### 5.3.2 Operational Tools

The following tools are required for carrying out a trial run using the motor unit.

| Operation tool | Function name | Reference |
|---|---|---|
| Set-up Support Software (PANATERM ver.7) | Trial run | *“5.3.3 Operation Procedure”* |

In preparation, please read the Set-up Support Software (PANATERM ver.7) Operating Manual carefully for usage notes and setup instructions when using the Set-up Support Software (PANATERM ver.7) .

The following operation procedure assumes normal connection of the Set-up Support Software (PANATERM ver.7) with the servo driver.

### 5.3.3 Operation Procedure

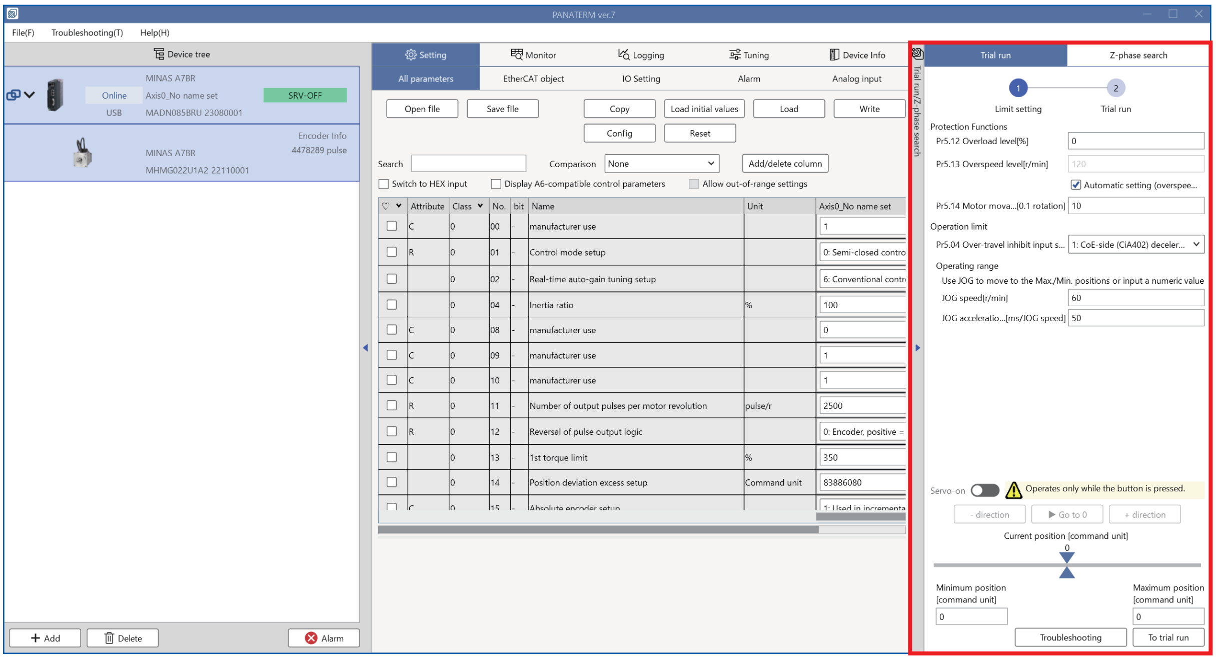
The procedure of the trial run (JOG operation) using the Set-up Support Software (PANATERM ver.7) is as follows.

**<< Procedure >>**

1. Activating the trial run function

   Double-click the Set-up Support Software (PANATERM ver.7) icon on the desktop of the PC where you installed Set-up Support Software (PANATERM ver.7) .

   The “Trial Run” screen appears on the right side of the main screen of the launched Set-up Support Software (PANATERM ver.7) .



MINAS A7BR
Axis0_No name set
MADN085BRU 23080001

Encoder Info
4478289 pulse
MINAS A7BR
MHMG022U1A2 22110001

Comparison: None

☐ Switch to HEX input ☐ Display A6-compatible control parameters ☐ Allow out-of-range settings

| | Attribute | Class | No. | bit | Name | Unit | Axis0_No name set |
|---|---|---|---|---|---|---|---|
| ☐ | C | 0 | 00 | - | manufacturer use | | 1 |
| ☐ | R | 0 | 01 | - | Control mode setup | | 0: Semi-closed contro |
| ☐ | | 0 | 02 | - | Real-time auto-gain tuning setup | | 6: Conventional contr |
| ☐ | | 0 | 04 | - | Inertia ratio | % | 100 |
| ☐ | C | 0 | 08 | - | manufacturer use | | 0 |
| ☐ | C | 0 | 09 | - | manufacturer use | | 1 |
| ☐ | C | 0 | 10 | - | manufacturer use | | 1 |
| ☐ | R | 0 | 11 | - | Number of output pulses per motor revolution | pulse/r | 2500 |
| ☐ | R | 0 | 12 | - | Reversal of pulse output logic | | 0: Encoder, positive = |
| ☐ | | 0 | 13 | - | 1st torque limit | % | 350 |
| ☐ | | 0 | 14 | - | Position deviation excess setup | Command unit | 83886080 |
| ☐ | C | 0 | 15 | - | Absolute encoder setup | | 1: Used in incrementa |

Protection Functions
Pr5.12 Overload level[%] 0
Pr5.13 Overspeed level[r/min] 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation] 10

Operation limit
Pr5.04 Over-travel inhibit input s... 1: CoE-side (CiA402) deceler...

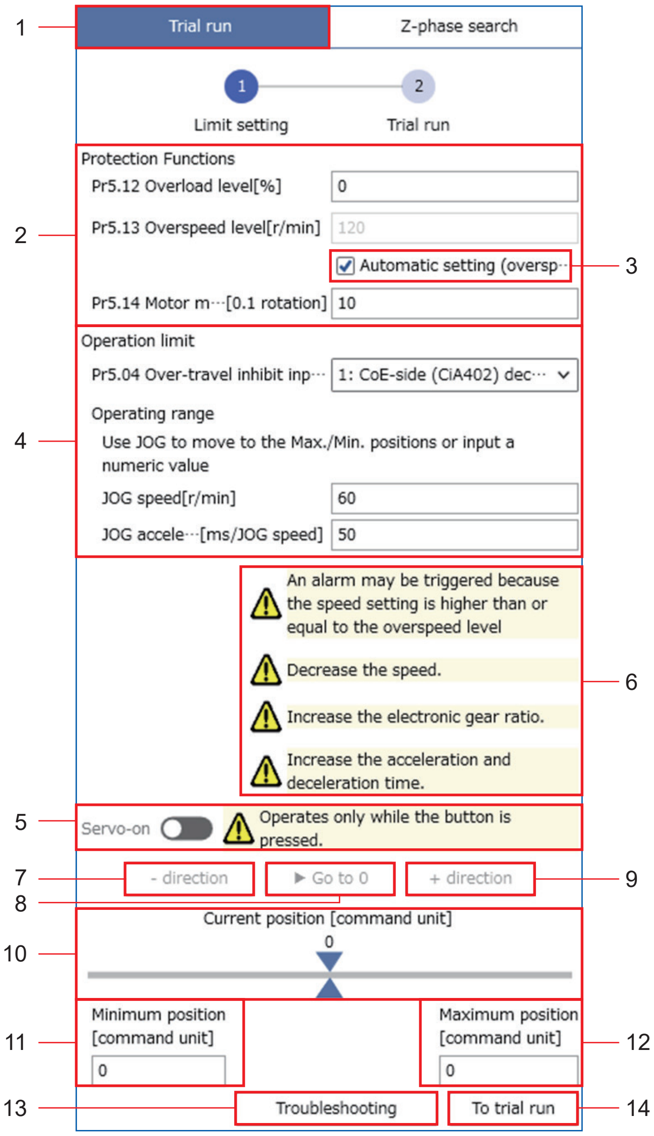
Operating range
Use JOG to move to the Max./Min. positions or input a numeric value
JOG speed[r/min] 60
JOG acceleratio...[ms/JOG speed] 50

Operates only while the button is pressed.

Current position [command unit] 0

Minimum position [command unit] 0
Maximum position [command unit] 0

### "Trial Run (Limit Setting)" Screen Details



Protection Functions

Pr5.12 Overload level[%] 0

Pr5.13 Overspeed level[r/min] 120

☑ Automatic setting (oversp···

Pr5.14 Motor m···[0.1 rotation] 10

Operation limit

Pr5.04 Over-travel inhibit inp··· 1: CoE-side (CiA402) dec···

Operating range

Use JOG to move to the Max./Min. positions or input a numeric value

JOG speed[r/min] 60

JOG accele···[ms/JOG speed] 50

An alarm may be triggered because the speed setting is higher than or equal to the overspeed level

Decrease the speed.

Increase the electronic gear ratio.

Increase the acceleration and deceleration time.

Operates only while the button is pressed.

Current position [command unit] 0

Minimum position [command unit] 0

Maximum position [command unit] 0

"Trial Run (Limit Setting)" Screen Button Operation Specifications

| | Name | Description | Reference item |
|---|---|---|---|
| 1 | Trial Run tab | Displays the train run function.<br>Limit setting is displayed first. | — |
| 2 | Protection functions | Sets parameters related to protection functions. | OI_A |
| 3 | Auto tuning (Overspeed) | When checked, the overspeed level changes to twice the JOG speed. | — |
| 4 | Operation limit | Sets parameters related to operation limits.<br>When the over-travel inhibit input setting is changed, it is written to the driver. | OI_A |
| 5 | Servo-on | Toggle the driver between servo-on/servo-off.<br>Servo-off can also be perform by pressing the ESC key.<br>If Set-up Support Software (PANATERM ver.7) is inactive while operating another application such as Excel, servo-off cannot be performed by pressing the ESC key. | — |
| 6 | Command saturation/ acceleration warning display | This message appears when the driver command value exceeds the operating limit or the speed setting is above the overspeed level. | PT_OM |

| | Name | Description | Reference item |
|---|---|---|---|
| 7 | Negative direction | The motor rotates while the button is pressed (direction of rotation depends on Pr0.00 “Rotational direction setup” or Obj.607Eh:00h “Polarity” ).<br>Enabled only during servo-on. | — |
| 8 | To position 0 | Performs step operation to the current position “0”.<br>Enabled only during servo-on and when the motor is not in the 0 position.<br>The current position of the motor is the command unit position set to 0 at servo-on. | — |
| 9 | Positive direction | The motor rotates while the button is pressed (direction of rotation depends on Pr0.00 “Rotational direction setup” or Obj.607Eh:00h “Polarity” ).<br>Enabled only during servo-on. | — |
| 10 | Current position/Minimum position/Maximum position slider | Indicates the current position of the motor and the minimum and maximum positions of the motor operating range.<br>Set the minimum and maximum positions by moving the “minimum position” and “maximum position” sliders [ ▲ ] left and right.<br>The current position of the motor is the command unit position set to 0 at servo-on. | — |
| 11 | Minimum position | Input a numerical value to set the minimum position of the motor operating range. | — |
| 12 | Maximum position | Input a numerical value to set the maximum position of the motor operating range. | — |
| 13 | Troubleshooting | Displays Troubleshooting. | PT_OM |
| 14 | To Trial Run | Displays the screen for executing the trial run. | — |

**2.** Related parameter settings

Sets “Protection functions” and “Operation limits”.

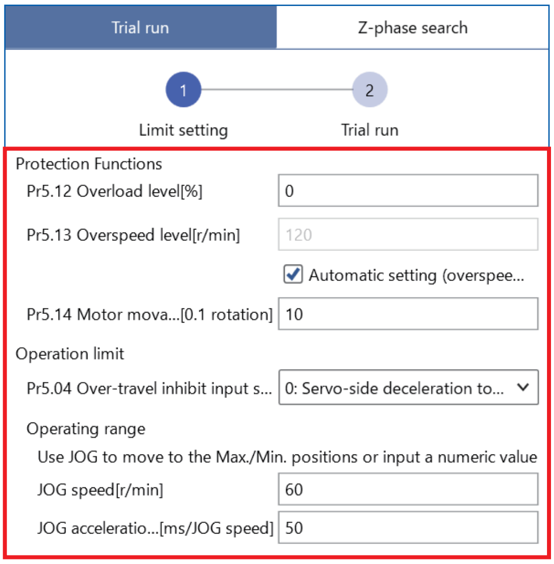
For related parameters, see *“6.2.2 Servo Parameter Area (3000h to 3FFFh)”* .

**Notes**

- The default values for “Protection Function” and “Operation Limit” are the values set in the Set-up Support Software (PANATERM ver.7) .

  The setup value for “Protection Function” is written to the servo driver just before the operation starts after the set value is changed.

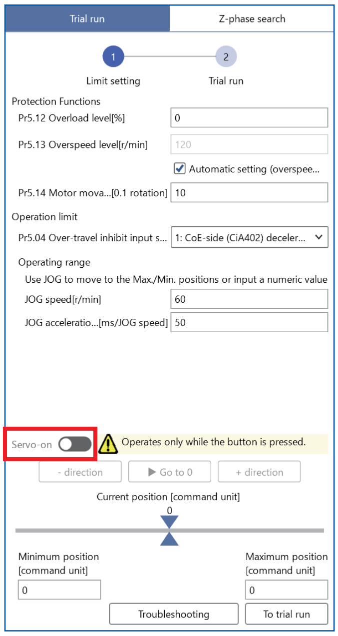
  The “Operation Limit” is written to the servo driver just before the operation starts after the set value is changed.



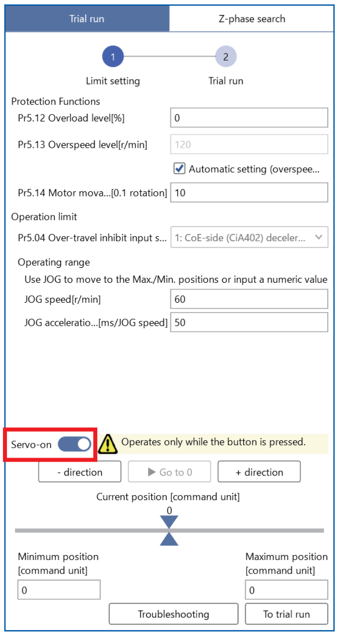
Protection Functions
Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation]: 10
Operation limit
Pr5.04 Over-travel inhibit input s...: 0: Servo-side deceleration to...
Operating range
Use JOG to move to the Max./Min. positions or input a numeric value
JOG speed[r/min]: 60
JOG acceleratio...[ms/JOG speed]: 50

**3.** Servo-on

Click “Servo-On” in the limit setting screen for “Trial Run” and put the driver in the servo-on state.



Protection Functions
Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation]: 10
Operation limit
Pr5.04 Over-travel inhibit input s...: 1: CoE-side (CiA402) deceler...
Operating range
Use JOG to move to the Max./Min. positions or input a numeric value
JOG speed[r/min]: 60
JOG acceleratio...[ms/JOG speed]: 50
Operates only while the button is pressed.
Current position [command unit]: 0
Minimum position [command unit]: 0
Maximum position [command unit]: 0



Protection Functions
Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation]: 10
Operation limit
Pr5.04 Over-travel inhibit input s...: 1: CoE-side (CiA402) deceler...
Operating range
Use JOG to move to the Max./Min. positions or input a numeric value
JOG speed[r/min]: 60
JOG acceleratio...[ms/JOG speed]: 50
Operates only while the button is pressed.
Current position [command unit]: 0
Minimum position [command unit]: 0
Maximum position [command unit]: 0

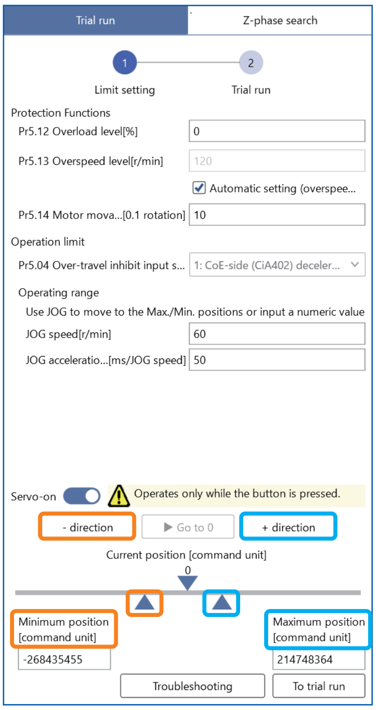
If a warning or error appears after servo-on, eliminate the cause. Then clear the alarm. Then, perform “Step 2” again.

**4.** Motor operating range setup

While checking the operation of the actual device, set the “Minimum position” and “Maximum position” of the motor operating range by moving the motor with the [- direction] and [+ direction] buttons.

**Notes**

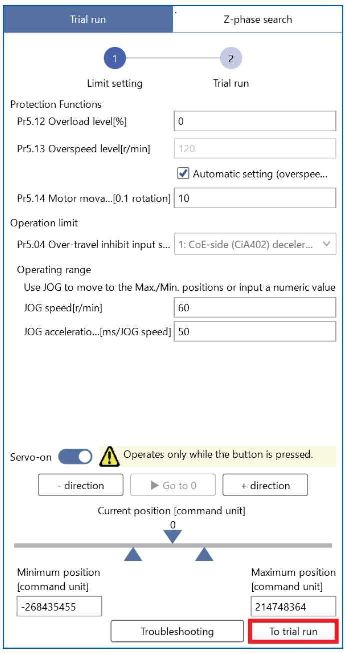
- The “Current position [command unit] 0” of the motor is the command unit position set to 0 at servo-on.



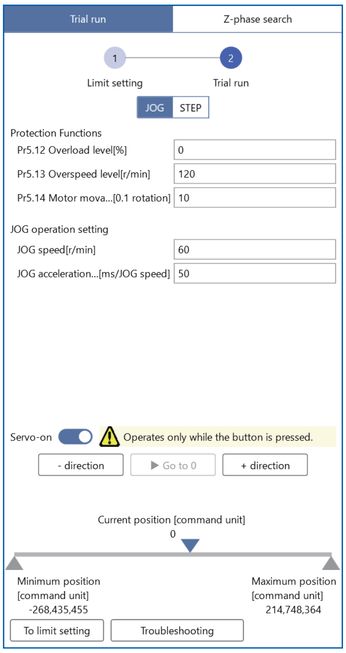
Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation]: 10
Pr5.04 Over-travel inhibit input s...: 1: CoE-side (CiA402) deceler...
JOG speed[r/min]: 60
JOG acceleratio...[ms/JOG speed]: 50
Current position [command unit]: 0
Minimum position [command unit]: -268435455
Maximum position [command unit]: 214748364

**5.** Applying the trial run parameters to the servo driver

Click [To Trial Run]. The operating range settings are applied to the servo driver and the screen switches.



Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation]: 10
Pr5.04 Over-travel inhibit input s...: 1: CoE-side (CiA402) deceler...
JOG speed[r/min]: 60
JOG acceleratio...[ms/JOG speed]: 50
Current position [command unit]: 0
Minimum position [command unit]: -268435455
Maximum position [command unit]: 214748364



Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
Pr5.14 Motor mova...[0.1 rotation]: 10
JOG speed[r/min]: 60
JOG acceleration...[ms/JOG speed]: 50
Current position [command unit]: 0
Minimum position [command unit]: -268,435,455
Maximum position [command unit]: 214,748,364

**— Precautions —**

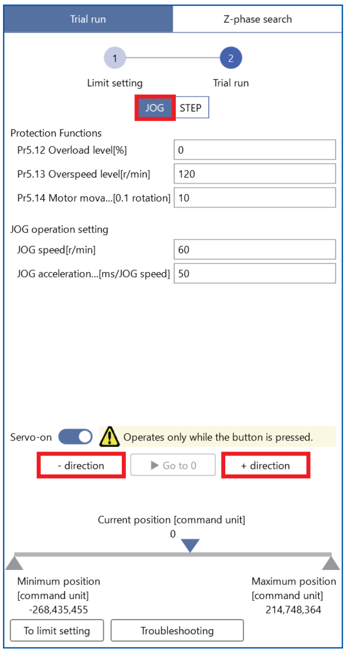
- If the [To trial run] button is clicked without changing the maximum and minimum positions, an operation that exceeds the actual scale is possible because the operating range is not limited. Be sure to set the maximum and minimum positions to avoid the risk of accidents.

**6.** Trial run (JOG operation)

Click the [JOG] button on the “Trial Run” screen to enable the JOG operation state.

Click the [–] and [+] direction buttons to confirm that the motor rotates. The motor continues to rotate as long as the [–] and [+] direction buttons are held down.

If a warning or error appears during the trial run, eliminate the cause. Then clear the alarm. Then start over from “Step 2”.



Protection Functions

Pr5.12 Overload level[%] 0

Pr5.13 Overspeed level[r/min] 120

Pr5.14 Motor mova...[0.1 rotation] 10

JOG operation setting

JOG speed[r/min] 60

JOG acceleration...[ms/JOG speed] 50

Servo-on

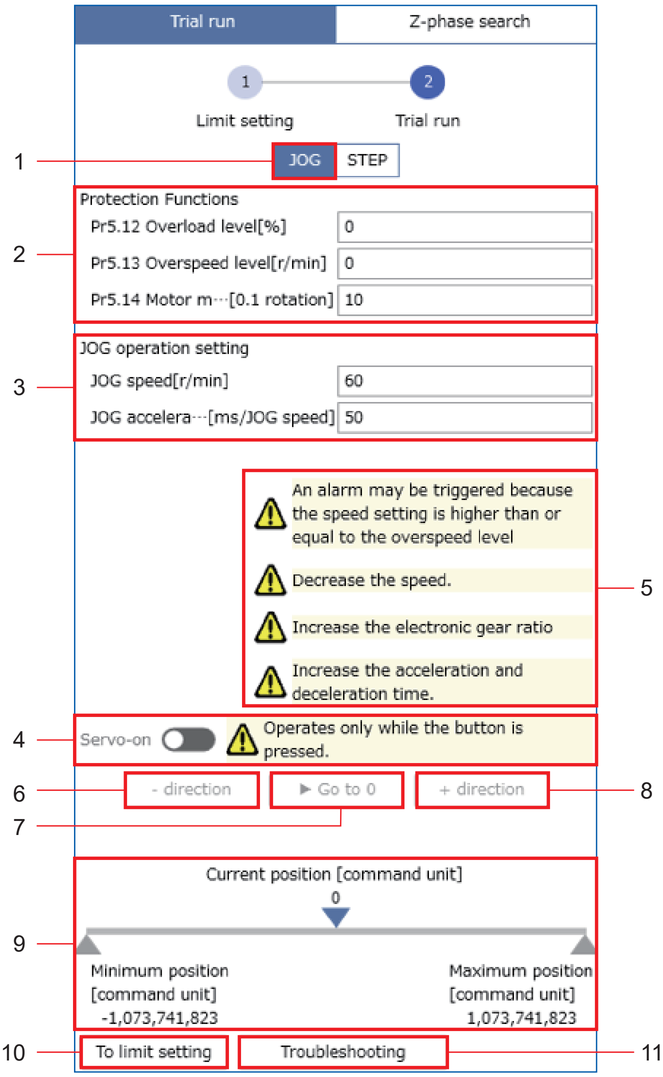
⚠ Operates only while the button is pressed.

Current position [command unit]
0

Minimum position
[command unit]
-268,435,455

Maximum position
[command unit]
214,748,364

### “Trail Run” Screen Details



Protection Functions

Pr5.12 Overload level[%] 0

Pr5.13 Overspeed level[r/min] 0

Pr5.14 Motor m···[0.1 rotation] 10

JOG operation setting

JOG speed[r/min] 60

JOG accelera···[ms/JOG speed] 50

⚠ An alarm may be triggered because the speed setting is higher than or equal to the overspeed level

⚠ Decrease the speed.

⚠ Increase the electronic gear ratio

⚠ Increase the acceleration and deceleration time.

Servo-on ⚠ Operates only while the button is pressed.

Current position [command unit] 0

Minimum position [command unit] -1,073,741,823

Maximum position [command unit] 1,073,741,823

“Trial Run” Screen Button Operation Specifications

| | Name | Description | Reference item |
|---|---|---|---|
| 1 | JOG | Switches to JOG operation. | — |
| 2 | Protection functions | Sets parameters related to protection functions.<br>Each time a setting is changed, it is written to the driver. | OI_A |
| 3 | JOG operation setting | Sets the speed and acceleration and deceleration time for JOG operation. | — |
| 4 | Servo-on | Toggle the driver between servo-on/servo-off.<br>Servo-off can also be perform by pressing the ESC key.<br>If Set-up Support Software (PANATERM ver.7) is inactive while operating another application such as Excel, servo-off cannot be performed by pressing the ESC key. | — |
| 5 | Command saturation/ acceleration warning display | This message appears when the driver command value exceeds the operating limit or the speed setting is above the overspeed level. | PT_OM |
| 6 | Negative direction | The motor rotates while the button is pressed (direction of rotation depends on Pr0.00 “Rotational direction setup” or Obj.607Eh:00h “Polarity” ).<br>Enabled only during servo-on. | — |

| | Name | Description | Reference item |
|---|---|---|---|
| 7 | To position 0 | Performs step operation to the current position “0”.<br>Enabled only during servo-on and when the motor is not in the 0 position.<br>The current position of the motor is the command unit position set to 0 at servo-on. | — |
| 8 | Positive direction | The motor rotates while the button is pressed (direction of rotation depends on Pr0.00 “Rotational direction setup” or Obj.607Eh:00h “Polarity” ).<br>Enabled only during servo-on. | — |
| 9 | Current position/Minimum position/Maximum position slider | Indicates the current position of the motor and the minimum and maximum positions of the motor operating range. | — |
| 10 | To limit setting | Displays the limit setting screen for the trial run. | — |
| 11 | Troubleshooting | Displays Troubleshooting. | PT_OM |

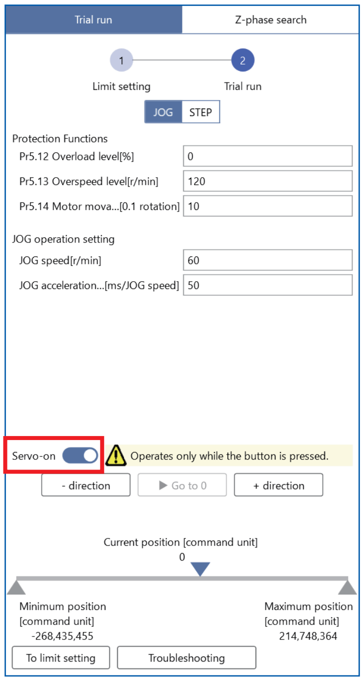
**7.** Finishing the trial run function

Ends the trial run or resets the operating range for the trial run.

- Ending the trial run

  Click the [Servo-on] button.

  This switches to a servo-off state, initializes the operating range, and transitions to the “Limit Setting” screen.



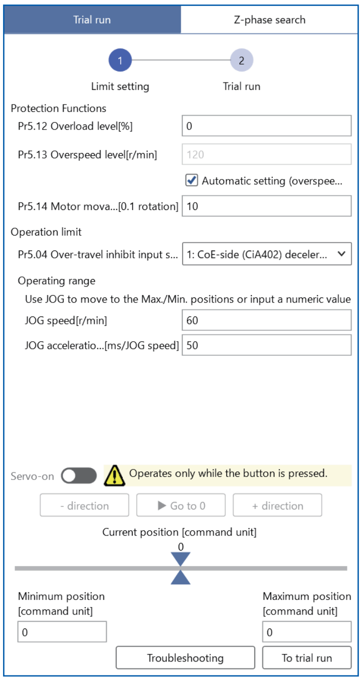
Protection Functions
Pr5.12 Overload level[%] 0
Pr5.13 Overspeed level[r/min] 120
Pr5.14 Motor mova...[0.1 rotation] 10

JOG operation setting
JOG speed[r/min] 60
JOG acceleration...[ms/JOG speed] 50

Operates only while the button is pressed.

Current position [command unit] 0

Minimum position [command unit] -268,435,455
Maximum position [command unit] 214,748,364



Protection Functions
Pr5.12 Overload level[%] 0
Pr5.13 Overspeed level[r/min] 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation] 10

Operation limit
Pr5.04 Over-travel inhibit input s... 1: CoE-side (CiA402) deceler...

Operating range
Use JOG to move to the Max./Min. positions or input a numeric value
JOG speed[r/min] 60
JOG acceleratio...[ms/JOG speed] 50

Operates only while the button is pressed.

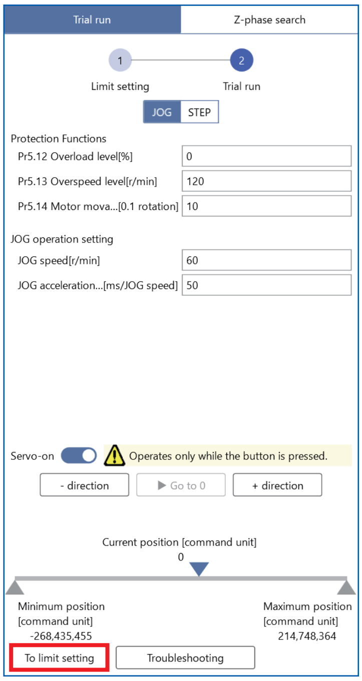
Current position [command unit] 0

Minimum position [command unit] 0
Maximum position [command unit] 0

- Changing the operating range of the motor

  Click the [To Limit Setting] button.

  This transitions to the “Limit Setting” screen while retaining the operating range. Then start over from <u>“Step 4”</u>.



Protection Functions
Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
Pr5.14 Motor mova...[0.1 rotation]: 10

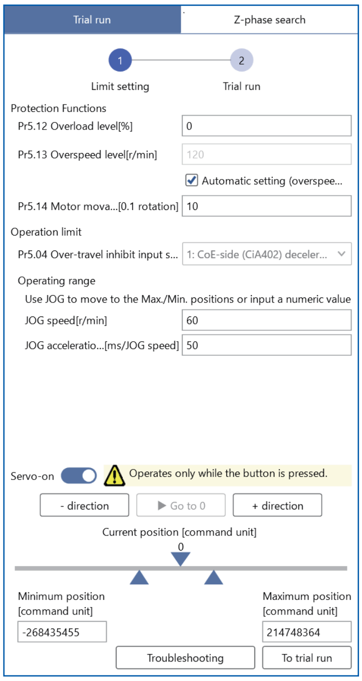
JOG operation setting
JOG speed[r/min]: 60
JOG acceleration...[ms/JOG speed]: 50

Operates only while the button is pressed.

Current position [command unit]
0

Minimum position [command unit]
-268,435,455

Maximum position [command unit]
214,748,364



Protection Functions
Pr5.12 Overload level[%]: 0
Pr5.13 Overspeed level[r/min]: 120
☑ Automatic setting (overspee...
Pr5.14 Motor mova...[0.1 rotation]: 10

Operation limit
Pr5.04 Over-travel inhibit input s...: 1: CoE-side (CiA402) deceler...

Operating range
Use JOG to move to the Max./Min. positions or input a numeric value
JOG speed[r/min]: 60
JOG acceleratio...[ms/JOG speed]: 50

Operates only while the button is pressed.

Current position [command unit]
0

Minimum position [command unit]: -268435455

Maximum position [command unit]: 214748364

The trial run with the motor unit using the Set-up Support Software (PANATERM ver.7) is now complete.

## 5.4 Trial Run via EtherCAT Communication

A motor operation check via EtherCAT communication from the host device side can be performed by connecting the host device to the servo driver.

Operation is described here using the Panasonic motion controller GM1 as the host device.

### 5.4.1 Items to Check Before Running the Trial

Ensure that the following items are checked before conducting the trial run.

- The main circuit power supply is ON.
- An alarm is not occurring.
- The status is at servo-off.
- Be ready to shut off power immediately in case of hazards such as unexpected operation of the motor.

### 5.4.2 Operational Tools

The following tools are required for trial run via EtherCAT communication from the host device.

| Operation tool | Function name | Reference |
|---|---|---|
| GM Programmer | Trial run | *“5.4.3 Operation Procedure”* |
| PANATERM Lite for GM | Servo driver communication settings | GM1 Controller EtherCAT User’s Manual (Setup) |

In preparation, carefully read the GM1 controller Operating Instructions, “GM1 Controller EtherCAT User’s Manual (Setup),” for precautions regarding use and setup of the host device GM1 Controller, GM Programmer, and PANATERM Lite for GM.

Servo driver initial settings are required to control the servo driver using the GM1 Controller. The initial settings can be configured easily using PANATERM Lite for GM.

After configuring the initial settings, the driver must be connected to the GM1 Controller in online setting mode to conduct the trial run using the GM Programmer.

The following operation procedure assumes normal connection of the GM1 Controller with the servo driver.

### 5.4.3 Operation Procedure

The operation procedure for a trial run using the GM Programmer is as follows.

A program does not need to be created for the trial run.

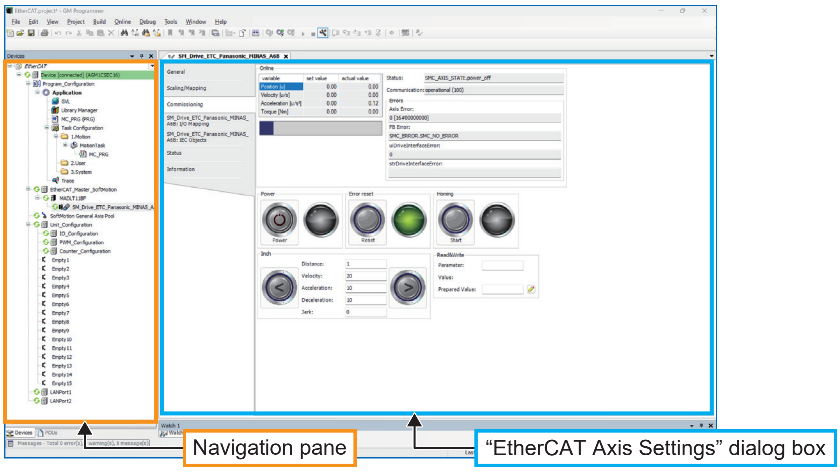
**<< Procedure >>**

**1.** Activating the trial run function

Click the [Start] button on the PC where GM Programmer is installed, and select **Panasonic Corporation**>**GM Programmer**.

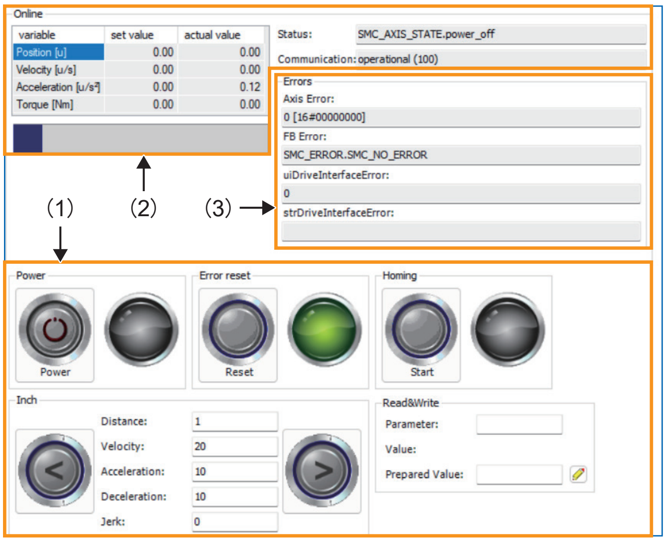
Select **Project**>**Online Setting Mode** on the menu bar.

Double-click on the servo driver object in the GM Programmer navigation window to display the “EtherCAT Axis Settings” dialog box.



Click on the “Trial run” tab in the “EtherCAT Axis Settings” dialog box. This displays the “Trial run” screen.

The “Trial Run” screen is composed of three areas.



Online

| variable | set value | actual value |
|---|---|---|
| Position [u] | 0.00 | 0.00 |
| Velocity [u/s] | 0.00 | 0.00 |
| Acceleration [u/s²] | 0.00 | 0.12 |
| Torque [Nm] | 0.00 | 0.00 |

Status: SMC_AXIS_STATE.power_off

Communication: operational (100)

Errors

Axis Error: 0 [16#00000000]

FB Error: SMC_ERROR.SMC_NO_ERROR

uiDriveInterfaceError: 0

strDriveInterfaceError:

Inch

Distance: 1

Velocity: 20

Acceleration: 10

Deceleration: 10

Jerk: 0

Read&Write

Parameter:

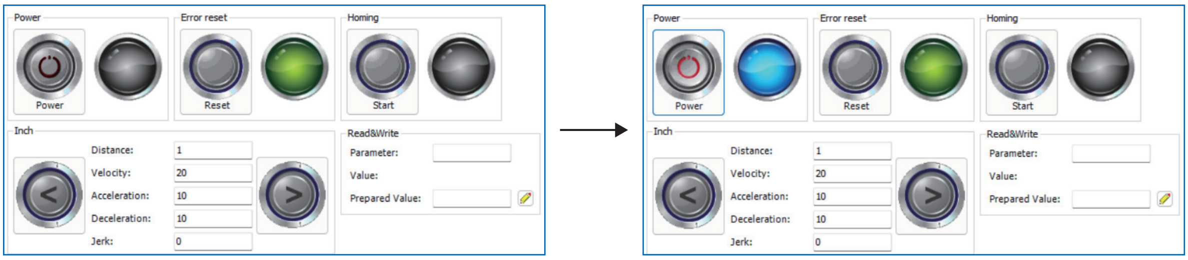
Value:

Prepared Value:

| No. | Area | Description |
|---|---|---|
| (1) | Operation | Sets the parameters for the trial run.<br>Executes the trial run. |
| (2) | Status | Displays the servo driver execution state during trial run execution. |
| (3) | Error | Displays the errors that occurred during trial run execution.<br>Executes error clearance. |

### 2. Servo-on

Click the power supply control icon in the operation area to turn to servo-on.



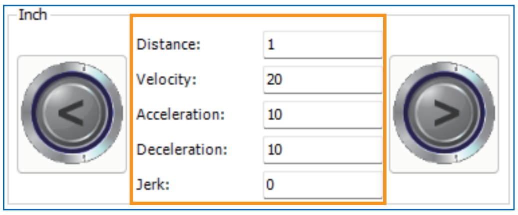
Distance: 1
Velocity: 20
Acceleration: 10
Deceleration: 10
Jerk: 0
Parameter:
Value:
Prepared Value:

After operating servo-on, refer to the 7-segment LED display on the front panel of the servo driver and check that the ESM state has transitioned from Pre-Op and that the servo is on. For the 7-segment LED display specifications, see *“3.4.3 7-Segment LED”* .

If an error appears within the error area after servo-on, eliminate the cause. Then execute error reset in the operation area and repeat step “Step 2”.

### 3. Related parameter settings

Input the setting parameters for during inching in related parameters in the inching area inside the operation area.

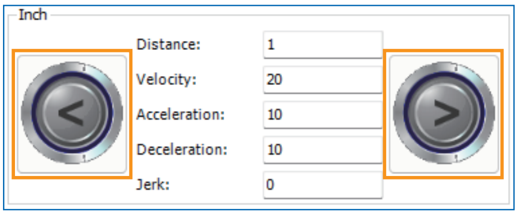


Distance: 1
Velocity: 20
Acceleration: 10
Deceleration: 10
Jerk: 0

### 4. Trial run (inching)

Activate each icon in the inch area inside the operation area to confirm that the motor rotates.

Click on 1 to perform inching (1 step positioning operation) according to the parameters set in “Step 3”.



Distance: 1
Velocity: 20
Acceleration: 10
Deceleration: 10
Jerk: 0

### 5. Ending the trial run function

Cancel Online Config Mode. The trial run function ends.

To cancel Online Config Mode, select **Project**>**Online Config Mode** on the menu bar.

The trial run (inching) via EtherCAT communication using the host device GM1 is now complete.

## 5.5 EtherCAT Homing Operation

### 5.5.1 Overview of Homing Operation

When using incremental mode for the encoder position control mode, homing is required before performing positioning.

With MINAS A7B, homing operation is possible in homing position control (hm) mode.

For details of homing, see *“6.6.5.5 Homing Position Control Mode (hm mode)”* .

# 6 Object

## 6.1 How to Read the Object Table

The following is an example of entries for the Object Table shown in this section.

### Example of table format

| Index | Sub-Index | Name | Units | Range | Data type (*1) | Access | PDO (*3) | Op-mode | EEPROM | Attribute (*6) |
|---|---|---|---|---|---|---|---|---|---|---|
| ***** | *** | ******* | ***** | ***** | VS | *** | RxPDO | *** | No | A |
| ***** | *** | ******* | ***** | ***** | U16 | *** | RxPDO | *** | No | A |
| ***** | *** | ******* | ***** | ***** | VS | *** | RxPDO | *** | Yes | A |

### Example of table format for describing details

| Index | Sub-Index | Name | Units | Range | Data type (*1) | Access (*2) | PDO (*3) | Op-mode (*4) | EEPROM (*5) | Attribute (*6) |
|---|---|---|---|---|---|---|---|---|---|---|
| ***** | *** | ******* | ***** | ***** | VS | *** | RxPDO | *** | No | A |
| | ******************** | | | | | | | | | |
| ***** | *** | ******* | ***** | ***** | U16 | *** | RxPDO | *** | No | A |
| | ******************** | | | | | | | | | |
| ***** | *** | ******* | ***** | ***** | VS | *** | RxPDO | *** | Yes | A |
| | ******************** | | | | | | | | | |

*1 “NULL” is placed at the end for objects in which the data type is “VS” (Visible String).

For the size of each object, check the object description, “The size of this object is ☐ byte(s).”

### Data type

| Abbreviation | Official name |
|---|---|
| U8 | Unsigned8 |
| U16 | Unsigned16 |
| U32 | Unsigned32 |
| I8 | Integer8 |
| I16 | Integer16 |
| I32 | Integer32 |
| VS | Visible String |
| BOOL | Boolean |
| OS | Octet String |

*2 Access indicates access settings.

### Access

| Abbreviation | Official name |
|---|---|
| rw | read-write |
| ro | read-only |
| c | constant |

*3 PDO indicates whether PDO mapping is available.

For details of PDO mapping, see *“6.3.3 Process Data Object (PDO) Mapping”* .

No: RxRDO, TxPDO mapping not available (only SDO)

RxPDO: RxPDO mapping available

TxPDO: TxPDO mapping available

*4 Op-mode indicates the corresponding control mode.

For the abbreviations of the control modes, see *“2.1.4.3 Supported Control Modes”* .

*5 EEPROM indicates whether the object is subject to back-ups.

Yes: Backed up

No: Not backed up

*6 "Attribute" indicates when object change descriptions are enabled.

All objects for which writing to EEPROM is not possible (“No” in the “EEPROM” column) appear as RO in Set-up Support Software (PANATERM ver.7) .

### Attribute

| Symbol | Description |
|---|---|
| A | Always enabled |
| B | Always enabled, but changes are prohibited while the motor is running and during command transfer. Changes while the motor is running and during position command transfer may transiently lead to unstable operation. |
| C | Enabled after control power reset and after running Config from Set-up Support Software (PANATERM ver.7) |
| R | Enabled after control power reset |
| P | Enabled when transitioning from Init to Pre-OP |
| S | Enabled when transitioning from Pre-OP to SafeOP |
| H | Enabled after determining position information |
| X | Objects that cannot be changed, such as read-only objects, or objects that aren’t supported |

## 6.2 Object Dictionary List

### 6.2.1 CoE Communication Area (1000h to 1FFFh)

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1000h | 00h | Device type | – | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | “6.3.1” |
| 1001h | 00h | Error register | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | – |
| | | ● bit 4: Generation of an alarm defined by AL status code | | | | | | | | | | “4.2.7.3.2”<br>“6.3.1” |
| | | ● bit 7: Generation of an alarm not defined by AL status code | | | | | | | | | | |
| 1008h | 00h | Manufacturer device name | – | – | – | VS | ro | No | ALL | No | X | “6.3.1” |
| 1009h | 00h | Manufacturer hardware version | – | – | – | VS | ro | No | ALL | No | X | |
| 100Ah | 00h | Manufacturer software version | – | – | – | VS | ro | No | ALL | No | X | |
| 1010h | – | Store parameters | – | – | – | – | – | – | – | – | – | “6.3.5” |
| | 00h | Number of entries | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Save all parameters | – | 0 to 4294967295 | 1 | U32 | rw | No | ALL | No | A | |
| 1018h | – | Identity object | – | – | – | – | – | – | – | – | – | “6.3.1” |
| | 00h | Number of entries | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Vendor ID | – | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | |
| | 02h | Product code | – | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | |
| | 03h | Revision number | – | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | |
| | 04h | Serial number | – | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | |
| 10F3h | – | Diagnosis history | – | – | – | – | – | – | – | – | – | “6.3.6” |
| | 00h | Number of entries | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Maximum messages | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | |
| | 02h | Newest message | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | |
| | 03h | Newest acknowledged message | – | 0 to 255 | 0 | U8 | rw | No | ALL | No | A | |
| | 04h | New messages available | – | 0 to 1 | – | BOOL | ro | No | ALL | No | X | |
| | 05h | Flags | – | 0 to 65535 | 39 | U16 | rw | No | ALL | Yes | A | – |
| | | ● bit 0: Emergency message execution permission | | | | | | | | | | “4.2.7.3.2”<br>“6.3.6” |
| | | ● bit 5: Diagnosis message clearing information | | | | | | | | | | |
| | 06h | Diagnosis message 1 | – | – | – | OS | ro | No | ALL | No | X | “6.3.6” |
| | ⋮ | | | | | | | | | | | |
| | 23h | Diagnosis message 30 | – | – | – | OS | ro | No | ALL | No | X | |
| 1600h | – | Receive PDO mapping 1 | – | – | – | – | – | – | – | – | – | “6.3.3.2” |
| | 00h | Number of entries | – | 0 to 32 | 4 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st receive PDO mapped | – | 0 to 4294967295 | 1614807056 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd receive PDO mapped | – | 0 to 4294967295 | 1616904200 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd receive PDO mapped | – | 0 to 4294967295 | 1618608160 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th receive PDO mapped | – | 0 to 4294967295 | 1622671376 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1600h | 07h | 7th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | *“6.3.3.2”* |
| | 08h | 8th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | | | | ⋮ | | | | | | | | |
| | 20h | 32nd receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1601h | – | Receive PDO mapping 2 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 7 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st receive PDO mapped | – | 0 to 4294967295 | 1614807056 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd receive PDO mapped | – | 0 to 4294967295 | 1616904200 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd receive PDO mapped | – | 0 to 4294967295 | 1618018320 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th receive PDO mapped | – | 0 to 4294967295 | 1618608160 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th receive PDO mapped | – | 0 to 4294967295 | 1619001376 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th receive PDO mapped | – | 0 to 4294967295 | 1622671376 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th receive PDO mapped | – | 0 to 4294967295 | 1627324448 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | | | | ⋮ | | | | | | | | |
| | 20h | 32nd receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1602h | – | Receive PDO mapping 3 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 6 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st receive PDO mapped | – | 0 to 4294967295 | 1614807056 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd receive PDO mapped | – | 0 to 4294967295 | 1616904200 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd receive PDO mapped | – | 0 to 4294967295 | 1618083856 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th receive PDO mapped | – | 0 to 4294967295 | 1618608160 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th receive PDO mapped | – | 0 to 4294967295 | 1622671376 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th receive PDO mapped | – | 0 to 4294967295 | 1627324448 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | | | | ⋮ | | | | | | | | |
| | 20h | 32nd receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1603h | – | Receive PDO mapping 4 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 8 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st receive PDO mapped | – | 0 to 4294967295 | 1614807056 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd receive PDO mapped | – | 0 to 4294967295 | 1616904200 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd receive PDO mapped | – | 0 to 4294967295 | 1618018320 | U32 | rw | No | ALL | Yes | S | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1603h | 04h | 4th receive PDO mapped | – | 0 to 4294967295 | 1618083856 | U32 | rw | No | ALL | Yes | S | *“6.3.3.2”* |
| | 05h | 5th receive PDO mapped | – | 0 to 4294967295 | 1618608160 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th receive PDO mapped | – | 0 to 4294967295 | 1619001376 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th receive PDO mapped | – | 0 to 4294967295 | 1622671376 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th receive PDO mapped | – | 0 to 4294967295 | 1627324448 | U32 | rw | No | ALL | Yes | S | |
| | 09h | 9th receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | | ⁝ | | | | | | | | | | |
| | 20h | 32nd receive PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1A00h | – | Transmit PDO mapping 1 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 8 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st transmit PDO mapped | – | 0 to 4294967295 | 1614741520 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd transmit PDO mapped | – | 0 to 4294967295 | 1614872592 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd transmit PDO mapped | – | 0 to 4294967295 | 1616969736 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th transmit PDO mapped | – | 0 to 4294967295 | 1617166368 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th transmit PDO mapped | – | 0 to 4294967295 | 1622736912 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th transmit PDO mapped | – | 0 to 4294967295 | 1622802464 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th transmit PDO mapped | – | 0 to 4294967295 | 1626603552 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th transmit PDO mapped | – | 0 to 4294967295 | 1627193376 | U32 | rw | No | ALL | Yes | S | |
| | 09h | 9th transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | | ⁝ | | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1A01h | – | Transmit PDO mapping 2 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 9 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st transmit PDO mapped | – | 0 to 4294967295 | 1614741520 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd transmit PDO mapped | – | 0 to 4294967295 | 1614872592 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd transmit PDO mapped | – | 0 to 4294967295 | 1616969736 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th transmit PDO mapped | – | 0 to 4294967295 | 1617166368 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th transmit PDO mapped | – | 0 to 4294967295 | 1617690656 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th transmit PDO mapped | – | 0 to 4294967295 | 1618411536 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th transmit PDO mapped | – | 0 to 4294967295 | 1622736912 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th transmit PDO mapped | – | 0 to 4294967295 | 1622802464 | U32 | rw | No | ALL | Yes | S | |
| | 09h | 9th transmit PDO mapped | – | 0 to 4294967295 | 1627193376 | U32 | rw | No | ALL | Yes | S | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A01h | 0Ah | 10th transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | *“6.3.3.2”* |
| | ⋮ | | | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1A02h | – | Transmit PDO mapping 3 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 9 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st transmit PDO mapped | – | 0 to 4294967295 | 1614741520 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd transmit PDO mapped | – | 0 to 4294967295 | 1614872592 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd transmit PDO mapped | – | 0 to 4294967295 | 1616969736 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th transmit PDO mapped | – | 0 to 4294967295 | 1617166368 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th transmit PDO mapped | – | 0 to 4294967295 | 1617690656 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th transmit PDO mapped | – | 0 to 4294967295 | 1618411536 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th transmit PDO mapped | – | 0 to 4294967295 | 1622736912 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th transmit PDO mapped | – | 0 to 4294967295 | 1622802464 | U32 | rw | No | ALL | Yes | S | |
| | 09h | 9th transmit PDO mapped | – | 0 to 4294967295 | 1627193376 | U32 | rw | No | ALL | Yes | S | |
| | 0Ah | 10th transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | ⋮ | | | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1A03h | – | Transmit PDO mapping 4 | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 0 to 32 | 9 | U8 | rw | No | ALL | Yes | S | |
| | 01h | 1st transmit PDO mapped | – | 0 to 4294967295 | 1614741520 | U32 | rw | No | ALL | Yes | S | |
| | 02h | 2nd transmit PDO mapped | – | 0 to 4294967295 | 1614872592 | U32 | rw | No | ALL | Yes | S | |
| | 03h | 3rd transmit PDO mapped | – | 0 to 4294967295 | 1616969736 | U32 | rw | No | ALL | Yes | S | |
| | 04h | 4th transmit PDO mapped | – | 0 to 4294967295 | 1617166368 | U32 | rw | No | ALL | Yes | S | |
| | 05h | 5th transmit PDO mapped | – | 0 to 4294967295 | 1617690656 | U32 | rw | No | ALL | Yes | S | |
| | 06h | 6th transmit PDO mapped | – | 0 to 4294967295 | 1618411536 | U32 | rw | No | ALL | Yes | S | |
| | 07h | 7th transmit PDO mapped | – | 0 to 4294967295 | 1622736912 | U32 | rw | No | ALL | Yes | S | |
| | 08h | 8th transmit PDO mapped | – | 0 to 4294967295 | 1622802464 | U32 | rw | No | ALL | Yes | S | |
| | 09h | 9th transmit PDO mapped | – | 0 to 4294967295 | 1627193376 | U32 | rw | No | ALL | Yes | S | |
| | 0Ah | 10th transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| | ⋮ | | | | | | | | | | | |
| | 20h | 32nd transmit PDO mapped | – | 0 to 4294967295 | 0 | U32 | rw | No | ALL | Yes | S | |
| 1C00h | – | Sync manager communication type | – | – | – | – | – | – | – | – | – | *“6.3.2”* |
| | 00h | Number of used sync manager channels | – | 0 to 255 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Communication type sync manager 0 | – | 0 to 4 | – | U8 | ro | No | ALL | No | X | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1C00h | 02h | Communication type sync manager 1 | — | 0 to 4 | — | U8 | ro | No | ALL | No | X | *“6.3.2”* |
| | 03h | Communication type sync manager 2 | — | 0 to 4 | — | U8 | ro | No | ALL | No | X | |
| | 04h | Communication type sync manager 3 | — | 0 to 4 | — | U8 | ro | No | ALL | No | X | |
| 1C12h | — | Sync manager channel 2 | — | — | — | — | — | — | — | — | — | *“6.3.3.1”* |
| | 00h | Number of assigned PDOs | — | 0 to 4 | 1 | U8 | rw | No | ALL | Yes | S | |
| | 01h | PDO mapping object index of assigned RxPDO 1 | — | 1600h to 1603h | 5632 | U16 | rw | No | ALL | Yes | S | |
| | 02h | PDO mapping object index of assigned RxPDO 2 | — | 1600h to 1603h | 5633 | U16 | rw | No | ALL | Yes | S | |
| | 03h | PDO mapping object index of assigned RxPDO 3 | — | 1600h to 1603h | 5634 | U16 | rw | No | ALL | Yes | S | |
| | 04h | PDO mapping object index of assigned RxPDO 4 | — | 1600h to 1603h | 5635 | U16 | rw | No | ALL | Yes | S | |
| 1C13h | — | Sync manager channel 3 | — | — | — | — | — | — | — | — | — | |
| | 00h | Number of assigned PDOs | — | 0 to 4 | 1 | U8 | rw | No | ALL | Yes | S | |
| | 01h | PDO mapping object index of assigned TxPDO 1 | — | 1A00h to 1A03h | 6656 | U16 | rw | No | ALL | Yes | S | |
| | 02h | PDO mapping object index of assigned TxPDO 2 | — | 1A00h to 1A03h | 6657 | U16 | rw | No | ALL | Yes | S | |
| | 03h | PDO mapping object index of assigned TxPDO 3 | — | 1A00h to 1A03h | 6658 | U16 | rw | No | ALL | Yes | S | |
| | 04h | PDO mapping object index of assigned TxPDO 4 | — | 1A00h to 1A03h | 6659 | U16 | rw | No | ALL | Yes | S | |
| 1C32h | — | Sync manager 2 synchronization | — | — | — | — | — | — | — | — | — | *“6.3.4”* |
| | 00h | Number of sub-objects | — | 0 to 255 | — | U8 | ro | No | ALL | No | X | |
| | 01h | Sync mode | — | 0 to 65535 | 2 | U16 | rw | No | ALL | Yes | S | |
| | 02h | Cycle time | ns | 0 to 4294967295 | 1000000 | U32 | rw | No | ALL | Yes | S | |
| | 03h | Shift time | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 04h | Sync modes supported | — | 0 to 65535 | — | U16 | ro | No | ALL | No | X | — |
| | | ● bit 0: FreeRun mode support | | | | | | | | | | *“6.3.4.1”*<br>*“6.3.4.5”* |
| | | ● bit 1: SM Synchronous mode support | | | | | | | | | | *“6.3.4.1”*<br>*“6.3.4.4”* |
| | | ● bits 4 to 2: DC synchronous mode support | | | | | | | | | | *“6.3.4.1”*<br>*“6.3.4.3”* |
| | | ● bits 6 to 5: Output shift support | | | | | | | | | | *“6.3.4.1”* |
| | 05h | Minimum cycle time | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | *“6.3.4”* |
| | 06h | Calc and copy time | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 08h | Command | — | 0 to 65535 | — | U16 | ro | No | ALL | No | X | |
| | 09h | Delay time | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 0Ah | Sync0 cycle time | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 0Bh | SM-event missed | — | 0 to 65535 | — | U16 | ro | No | ALL | No | X | |
| | 0Ch | Cycle time too small | — | 0 to 65535 | — | U16 | ro | No | ALL | No | X | |
| | 0Dh | Shift time too short | — | 0 to 65535 | — | U16 | ro | No | ALL | No | X | |
| | 0Eh | RxPDO toggle failed | — | 0 to 65535 | — | U16 | ro | No | ALL | No | X | |
| | 20h | Sync error | — | 0 to 1 | — | BOOL | ro | No | ALL | No | X | |
| 1C33h | — | Sync manager 3 synchronization | — | — | — | — | — | — | — | — | — | |
| | 00h | Number of sub-objects | — | 0 to 255 | — | U8 | ro | No | ALL | No | X | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1C33h | 01h | Sync mode | – | 0 to 65535 | 2 | U16 | rw | No | ALL | Yes | S | *“6.3.4”* |
|  | 02h | Cycle time | ns | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X |  |
|  | 03h | Shift time | ns | 0 to 4294967295 | 0 | U32 | rw | No | ALL | No | S |  |
|  | 04h | Sync modes supported | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X | – |
|  |  | ● bit 0: FreeRun mode support |  |  |  |  |  |  |  |  |  | *“6.3.4.2”*<br>*“6.3.4.5”* |
|  |  | ● bit 1: SM Synchronous mode support |  |  |  |  |  |  |  |  |  | *“6.3.4.2”*<br>*“6.3.4.4”* |
|  |  | ● bits 4 to 2: DC synchronous mode support |  |  |  |  |  |  |  |  |  | *“6.3.4.2”*<br>*“6.3.4.3”* |
|  |  | ● bits 6 to 5: Output Shift Support Input Shift Support |  |  |  |  |  |  |  |  |  | *“6.3.4.2”* |
|  | 05h | Minimum cycle time | ns | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | *“6.3.4”* |
|  | 06h | Calc and copy time | ns | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X |  |
|  | 08h | Command | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X |  |
|  | 09h | Delay time | ns | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X |  |
|  | 0Ah | Sync0 cycle time | ns | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X |  |
|  | 0Bh | SM-event missed | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X |  |
|  | 0Ch | Cycle time too small | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X |  |
|  | 0Dh | Shift time too short | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X |  |
|  | 0Eh | RxPDO toggle failed | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X |  |
|  | 20h | Sync error | – | 0 to 1 | – | BOOL | ro | No | ALL | No | X |  |

## 6.2.2 Servo Parameter Area (3000h to 3FFFh)

For correspondence between parameter numbers and object numbers, see *“6.4 Servo Parameter Area (3000h to 3FFFh) Details”* .

### 6.2.2.1 Class 0: Basic Settings

—: N/A

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3000h | 00h | Reserved | — | — | 1 | I16 | — | — | — | — | — | — |
| 3001h | 00h | Control mode setup | — | 0 to 6 | 0 | I16 | rw | No | ALL | Yes | R | *“7.6.6”* |
| 3002h | 00h | Real-time auto-gain tuning setup | — | 0 to 7 | 1 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3003h | 00h | Real-time auto-tuning machine stiffness setup | — | 0 to 31 | Sizes A, B: 13<br>Sizes C, D: 11 (13) (*3) | I16 | rw | No | ALL | Yes | B | |
| 3004h | 00h | Inertia ratio | % | 0 to 100000 | 250 | I32 | rw | No | ALL | Yes | B | OI_A |
| 3008h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3009h | 00h | Reserved | — | — | 1 | I32 | — | — | — | — | — | |
| 3010h | 00h | Reserved | — | — | 1 | I32 | — | — | — | — | — | |
| 3011h | 00h | Number of output pulses per motor revolution | pulse/r | 1 to 33554432 | 2500 | I32 | rw | No | ALL | Yes | R | *“8.6”* |
| 3012h | 00h | Reversal of pulse output logic | — | 0 to 3 | 0 | I16 | rw | No | ALL | Yes | R | |
| 3013h | 00h | 1st torque limit | % | 0 to 500 | 500 (*2) | I16 | rw | No | ALL | Yes | B | *“8.1”* |
| 3014h | 00h | Position deviation excess setup | Command unit | 0 to 1073741824 | 83886080 | I32 | rw | No | csp<br>pp<br>hm<br>ip | Yes | A | *“7.2.9”*<br>*“Err24.0.0”* |
| 3015h | 00h | Absolute encoder setup | — | 0 to 4 | 1 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S)<br>csv (S)<br>pv (S)<br>cst (S)<br>tq (S) | Yes | C | *“7.2.7”*<br>*“7.6.6”*<br>*“8.4”*<br>*“8.5”* |
| 3016h | 00h | External regenerative resistor setup | — | 0 to 3 | Sizes A, B: 3<br>Sizes C, D: 0 | I16 | rw | No | ALL | Yes | C | *“7.2.6”* |
| 3017h | 00h | Selection of load factor for external regenerative resistor | — | 0 to 4 | 0 | I16 | rw | No | ALL | Yes | C | |
| 3018h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3022h | 00h | Sensor feedback control mode setup (*1) | — | 0 to 1 | 0 | I16 | rw | No | csp | Yes | R | *“6.6.5.3.6”* |
| 3027h | 00h | Selection of machine stiffness at real-time auto-gain tuning 2 | — | 0 to 44 | Sizes A, B: 16<br>Sizes C, D: 12 (16) (*3) | I16 | rw | No | ALL | Yes | B | OI_A |
| 3028h | 00h | Selection of feed forward stiffness at real-time auto-gain tuning | — | 0 to 44 | Sizes A, B: 16<br>Sizes C, D: 12 (16) (*3) | I16 | rw | No | ALL | Yes | B | |

*1 Cannot be used with the standard type or multi-function type. Do not change the factory default value.

*2 Factory default values vary depending on the servo driver and motor combination.

For details, see *“8.1 Torque Limit Switching Function”* .

*3 Values in parentheses are initial values for models with an instantaneous maximum current (peak value) of less than 24 A.

### 6.2.2.2 Class 1: Gain Adjustment

—: N/A

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3100h | 00h | 1st gain of position loop | 0.1 $s^{-1}$ | 0 to 30000 | Sizes A, B: 480<br>Sizes C, D: 320 (480) (*1) | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3101h | 00h | 1st velocity loop gain | 0.1 Hz | 1 to 32767 | Sizes A, B: 270<br>Sizes C, D: 180 (270) (*1) | I16 | rw | No | ALL | Yes | B | |
| 3102h | 00h | 1st velocity loop integration time constant | 0.1 ms | 1 to 10000 | Sizes A, B: 210<br>Sizes C, D: 310 (210) (*1) | I16 | rw | No | ALL | Yes | B | |
| 3103h | 00h | 1st filter of velocity detection | — | 0 to 5 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3104h | 00h | 1st torque filter time constant | 0.01 ms | 0 to 2500 | Sizes A, B: 84<br>Sizes C, D: 126 (84) (*1) | I16 | rw | No | ALL | Yes | B | OI_A |
| 3105h | 00h | 2nd gain of position loop | 0.1 $s^{-1}$ | 0 to 30000 | Sizes A, B: 480<br>Sizes C, D: 320 (480) (*1) | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3106h | 00h | 2nd velocity loop gain | 0.1 Hz | 1 to 32767 | Sizes A, B: 270<br>Sizes C, D: 180 (270) (*1) | I16 | rw | No | ALL | Yes | B | |
| 3107h | 00h | 2nd velocity loop integration time constant | 0.1 ms | 1 to 10000 | Sizes A, B: 210<br>Sizes C, D: 310 (210) (*1) | I16 | rw | No | ALL | Yes | B | |
| 3108h | 00h | 2nd filter of velocity detection | — | 0 to 5 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3109h | 00h | 2nd torque filter time constant | 0.01 ms | 0 to 2500 | Sizes A, B: 84<br>Sizes C, D: 126 (84) (*1) | I16 | rw | No | ALL | Yes | B | OI_A |
| 3110h | 00h | Velocity feed forward gain | 0.1% | 0 to 4000 | 1000 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3111h | 00h | Velocity feed forward filter | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3112h | 00h | Torque feed forward gain | 0.1% | 0 to 2000 | 1000 | I16 | rw | No | ALL | Yes | B | |
| 3113h | 00h | Torque feed forward filter | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3114h | 00h | 2nd gain setup | — | 0 to 1 | 1 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3115h | 00h | Mode of position control switching | — | 0 to 10 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3116h | 00h | Delay time of position control switching | 0.1 ms | 0 to 10000 | 10 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3117h | 00h | Level of position control switching | – | 0 to 20000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3118h | 00h | Hysteresis at position control switching | – | 0 to 20000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3119h | 00h | Position gain switching time | 0.1 ms | 0 to 10000 | 10 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3120h | 00h | Mode of velocity control switching | – | 0 to 5 | 0 | I16 | rw | No | csv<br>pv | Yes | B | |
| 3121h | 00h | Delay time of velocity control switching | 0.1 ms | 0 to 10000 | 0 | I16 | rw | No | csv<br>pv | Yes | B | |
| 3122h | 00h | Level of velocity control switching | – | 0 to 20000 | 0 | I16 | rw | No | csv<br>pv | Yes | B | |
| 3123h | 00h | Hysteresis at velocity control switching | – | 0 to 20000 | 0 | I16 | rw | No | csv<br>pv | Yes | B | |
| 3124h | 00h | Mode of torque control switching | – | 0 to 3 | 0 | I16 | rw | No | cst<br>tq | Yes | B | |
| 3125h | 00h | Delay time of torque control switching | 0.1 ms | 0 to 10000 | 0 | I16 | rw | No | cst<br>tq | Yes | B | |
| 3126h | 00h | Level of torque control switching | – | 0 to 20000 | 0 | I16 | rw | No | cst<br>tq | Yes | B | |
| 3127h | 00h | Hysteresis at torque control switching | – | 0 to 20000 | 0 | I16 | rw | No | cst<br>tq | Yes | B | |
| 3128h | 00h | Reserved | – | – | 0 | I16 | – | – | – | – | – | – |
| ⋮ | | | | | | | | | | | | |
| 3178h | 00h | Reserved | – | – | 0 | I16 | – | – | – | – | – | |
| 31A6h | 00h | 1st position loop gain change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | OI_A |
| 31A7h | 00h | 1st velocity integration change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31A8h | 00h | 1st torque filter change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31A9h | 00h | 2nd position loop gain change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31B0h | 00h | 2nd velocity loop gain change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31B1h | 00h | 2nd velocity integration change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31B2h | 00h | 2nd torque filter change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31B3h | 00h | Load fluctuation compensation filter change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31B4h | 00h | Smoothing filter change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |
| 31B5h | 00h | Tuning filter change ratio | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | |

*1 Values in parentheses are initial values for models with an instantaneous maximum current (peak value) of less than 24 A.

### 6.2.2.3 Class 2: Vibration Suppression

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3200h | 00h | Adaptive filter mode setup | – | 0 to 6 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | OI_A |
| 3201h | 00h | 1st notch frequency | Hz | 10 to 5000 | 5000 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3202h | 00h | 1st notch width selection | – | 0 to 20 | 2 | I16 | rw | No | ALL | Yes | B | |
| 3203h | 00h | 1st notch depth selection | – | 0 to 99 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3204h | 00h | 2nd notch frequency | Hz | 10 to 5000 | 5000 | I16 | rw | No | ALL | Yes | B | |
| 3205h | 00h | 2nd notch width selection | – | 0 to 20 | 2 | I16 | rw | No | ALL | Yes | B | |
| 3206h | 00h | 2nd notch depth selection | – | 0 to 99 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3207h | 00h | 3rd notch frequency | Hz | 10 to 5000 | 5000 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3208h | 00h | 3rd notch width selection | – | 0 to 20 | 2 | I16 | rw | No | ALL | Yes | B | |
| 3209h | 00h | 3rd notch depth selection | – | 0 to 99 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3210h | 00h | 4th notch frequency | Hz | 10 to 5000 | 5000 | I16 | rw | No | ALL | Yes | B | |
| 3211h | 00h | 4th notch width selection | – | 0 to 20 | 2 | I16 | rw | No | ALL | Yes | B | |
| 3212h | 00h | 4th notch depth selection | – | 0 to 99 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3213h | 00h | Selection of damping filter switching | – | 0 to 7 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3214h | 00h | 1st damping frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3215h | 00h | 1st damping filter setup | 0.1 Hz | 0 to 1500 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3216h | 00h | 2nd damping frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3217h | 00h | 2nd damping filter setup | 0.1 Hz | 0 to 1500 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3218h | 00h | 3rd damping frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3219h | 00h | 3rd damping filter setup | 0.1 Hz | 0 to 1500 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3220h | 00h | 4th damping frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3221h | 00h | 4th damping filter setup | 0.1 Hz | 0 to 1500 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3222h | 00h | Positional command smoothing filter | 0.1 ms | 0 to 10000 | Sizes A, B: 92<br>Sizes C, D: 139 (92) (*1) | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | “7.3.2”<br>“7.3.3”<br>“7.4.2”<br>“7.6.2”<br>“7.6.3”<br>OI_A |
| 3223h | 00h | Positional command FIR filter | 0.1 ms | 0 to 10000 | 10 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3224h | 00h | 5th notch frequency | Hz | 10 to 5000 | 5000 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3225h | 00h | 5th notch width selection | — | 0 to 20 | 2 | I16 | rw | No | ALL | Yes | B | |
| 3226h | 00h | 5th notch depth selection | — | 0 to 99 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3227h | 00h | 1st damping width setting | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3228h | 00h | 2nd damping width setting | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3229h | 00h | 3rd damping width setting | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3230h | 00h | 4th damping width setting | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3231h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| ⋮ | | | | | | | | | | | | |
| 3237h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | |
| 3238h | 00h | Filter function switching | — | -32768 to 32767 | 3 | I16 | rw | No | ALL | Yes | B | — |
| | | ● bit 0: Custom notch filter | | | | | | | | | | “7.3.2”<br>“7.4.2”<br>“7.6.2” |
| | | ● bit 1: Tuning filter 2 | | | | | | | | | | “7.3.2”<br>“7.4.2”<br>“7.6.2”<br>OI_A |
| 3239h | 00h | Custom notch compensation coefficient | 0.01 | 0 to 1000 | 0 | I16 | rw | No | ALL | Yes | B | “7.3.2”<br>“7.4.2”<br>“7.6.2”<br>OI_A |
| 3240h | 00h | Custom notch compensation frequency1 | 0.1 Hz | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3241h | 00h | Custom notch compensation frequency2 | 0.1 Hz | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3242h | 00h | Custom notch frequency | Hz | 10 to 5000 | 5000 | I16 | rw | No | ALL | Yes | B | |
| 3243h | 00h | Custom notch width | — | 0 to 20 | 2 | I16 | rw | No | ALL | Yes | B | |
| 3244h | 00h | Custom notch depth | — | 0 to 99 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3245h | 00h | Function expansion setup 10 | — | -2147483648 to 2147483647 | 61 | I32 | rw | No | ALL | Yes | B | — |
| | | ● bit 1 to 0: Two-degree-of-freedom control function setting | | | | | | | | | | “7.2.5”<br>OI_A |
| | | ● bit 2: Friction torque compensation parameter selection | | | | | | | | | | OI_A |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3245h | 00h | • bit 3: Load fluctuation suppression function automatic calculation | | | | | | | | | | OI_A |
| | | • bit 5 to 4: Stiffness setting resolution, individual FB/FF setting switching | | | | | | | | | | OI_A |
| 3246h | 00h | Tuning filter 2 | 0.01 ms | 0 to 20000 | Size A: 110<br>Size B: 120<br>Sizes C, D: 170 (120) (*1) | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | *"7.2.5"*<br>*"7.3.2"*<br>*"7.6.2"* |
| 3250h | 00h | Detection start vibration count | — | 0 to 100 | 3 | I16 | rw | No | csp<br>pp | Yes | B | OI_A |
| 3251h | 00h | Detected vibration amplitude | Command unit | 0 to 134217728 | 0 | I32 | rw | No | csp<br>pp | Yes | B | |
| 3252h | 00h | Torque command additional value 2 | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | OI_A |
| 3253h | 00h | Positive direction torque compensation value 2 | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3254h | 00h | Negative direction torque compensation value 2 | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3261h | 00h | Target settling time | ms | 0 to 32767 | 0 | I16 | rw | No | ALL | Yes | A | OI_A |
| 3262h | 00h | Settling time count condition | — | 0 to 1 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3263h | 00h | Allowable overshoot amount | % | 0 to 500 | 100 | I16 | rw | No | ALL | Yes | A | |
| 3264h | 00h | Tuning amount of movement | Command unit | 0 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3265h | 00h | Tuning max speed | r/min | 0 to 20000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3266h | 00h | Tuning acceleration and deceleration time | ms | 0 to 5000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3267h | 00h | Tuning wait time | ms | 0 to 10000 | 2000 | I16 | rw | No | ALL | Yes | A | |
| 3268h | 00h | Tuning operating range upper limit | Command unit | 0 to 1073741823 | 8388608 | I32 | rw | No | ALL | Yes | A | |
| 3269h | 00h | Tuning operating range lower limit | Command unit | -1073741824 to 0 | -8388608 | I32 | rw | No | ALL | Yes | A | |
| 3270h | 00h | Tuning overspeed level setting | r/min | 0 to 20000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3271h | 00h | Tuning torque limit | % | 0 to 500 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3272h | 00h | Tuning start RTAT machine stiffness setting | — | 0 to 44 | 8 | I16 | rw | No | ALL | Yes | A | |
| 3273h | 00h | Tuning stability margin | % | 0 to 100 | 80 | I16 | rw | No | ALL | Yes | A | |
| 3274h | 00h | Tuning auto tuning application selection | — | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | A | OI_A |
| 3275h | 00h | Tuning step selection | — | -32768 to 32767 | 3 | I16 | rw | No | ALL | Yes | A | — |
| | | • bit 0: Advance operation | | | | | | | | | | OI_A |
| | | • bit 1: Homing operation | | | | | | | | | | |
| 3276h | 00h | Tuning target function selection | — | -32768 to 32767 | 1009 | I16 | rw | No | ALL | Yes | A | — |
| | | • bit 0: Inertia ratio | | | | | | | | | | OI_A |
| | | • bit 1: Unbalanced load compensation (default disabled) | | | | | | | | | | |
| | | • bit 2: Dynamic friction compensation (default disabled) | | | | | | | | | | |
| | | • bit 3: Viscous friction compensation (default disabled) | | | | | | | | | | |
| | | • bit 4: RTAT machine stiffness setting (position and speed gains, speed integration time constant, torque filter) | | | | | | | | | | |
| | | • bit 5: RTAT feedforward control section stiffness setting (smoothing filter time constant) | | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3276h | 00h | ● bit 6: Notch filter<br>● bit 7: 1st damping filter<br>● bit 8: 2nd damping filter<br>● bit 9: Load fluctuation control function | | | | | | | | | | OI_A |
| 3277h | 00h | Tuning start position | Command unit | -1073741824 to 1073741823 | 0 | I32 | rw | No | ALL | Yes | A | OI_A |
| 3278h | 00h | Tuning vibration automatic suppression effective level | % | 0 to 100 | 15 | I16 | rw | No | ALL | Yes | A | |
| 3279h | 00h | Tuning JOG test run command speed | r/min | 0 to 500 | 60 | I16 | rw | No | ALL | Yes | A | |
| 3280h | 00h | Tuning JOG test run acceleration and deceleration time | ms | 0 to 5000 | 50 | I16 | rw | No | ALL | Yes | A | |

*1 Values in parentheses are initial values for models with an instantaneous maximum current (peak value) of less than 24 A.

### 6.2.2.4 Class 3: Velocity/Torque Control/Full-closed Control

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3304h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| | | | | ⋮ | | | | | | | | |
| 3307h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | |
| 3312h | 00h | Acceleration time setup | ms/<br>(1000 r/min) | 0 to 10000 | 0 | I16 | rw | No | csv<br>pv | Yes | B | OI_A |
| 3313h | 00h | Deceleration time setup | ms/<br>(1000 r/min) | 0 to 10000 | 0 | I16 | rw | No | csv<br>pv | Yes | B | |
| 3314h | 00h | Sigmoid acceleration / deceleration time setup | ms | 0 to 1000 | 0 | I16 | rw | No | csv<br>pv | Yes | B | |
| 3317h | 00h | Selection of speed limit | — | 2 | 2 | I16 | rw | No | cst<br>tq | Yes | B | *“7.5.2”* |
| 3321h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3322h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3323h | 00h | External scale selection | — | 0 to 2 | 0 | I16 | rw | No | ALL | Yes | R | *“7.2.8”*<br>*“7.6.6”*<br>*“8.8”* |
| 3324h | 00h | Numerator of external scale division | — | 0 to 134217728 | 0 | I32 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | R | *“7.6.4”*<br>*“7.6.6”* |
| 3325h | 00h | Denominator of external scale division | — | 1 to 134217728 | 10000 | I32 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | R | |
| 3326h | 00h | Reversal of direction of external scale | — | 0 to 3 | 0 | I16 | rw | No | ALL | Yes | R | *“7.2.8”*<br>*“7.6.6”*<br>*“8.8”* |
| 3327h | 00h | External scale Z phase disconnection detection disable | — | 0 to 1 | 0 | I16 | rw | No | ALL | Yes | R | *“8.8”* |
| 3328h | 00h | Hybrid deviation excess setup | Command unit | 1 to 134217728 | 16000 | I32 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | C | *“7.6.5”* |
| 3329h | 00h | Hybrid deviation clear setup | Rotation | 0 to 100 | 0 | I16 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | C | |
| 3333h (*1) | 00h | Analog input gain | Command unit/mV | 0 to 30000 | 0 | I16 | rw | No | csp | Yes | B | *“6.6.5.3.6”* |
| 3334h (*1) | 00h | Analog input polarity | — | 0 to 1 | 0 | I16 | rw | No | csp | Yes | B | |
| 3335h (*1) | 00h | Analog input integration time constant | 0.01 ms | 0 to 100000 | 0 | I32 | rw | No | csp | Yes | B | |
| 3336h (*1) | 00h | Analog input integration limit | Command unit/mV | 0 to 2147483647 | 0 | I32 | rw | No | csp | Yes | B | |

*1 Cannot be used with the standard type or multi-function type. Do not change the factory default value.

### 6.2.2.5 Class 4: I/O Monitor Settings

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3400h | 00h | SI1 input selection | — | 0 to 16777215 | 3289650 | I32 | rw | No | ALL | Yes | C | *“3.2.5.4.2”* |
| 3401h | 00h | SI2 input selection | — | 0 to 16777215 | 8487297 | I32 | rw | No | ALL | Yes | C | |
| 3402h | 00h | SI3 input selection | — | 0 to 16777215 | 8553090 | I32 | rw | No | ALL | Yes | C | |
| 3403h | 00h | SI4 input selection | — | 0 to 16777215 | 2236962 | I32 | rw | No | ALL | Yes | C | |
| 3404h | 00h | SI5 input selection | — | 0 to 16777215 | 2105376 | I32 | rw | No | ALL | Yes | C | |
| 3405h | 00h | SI6 input selection | — | 0 to 16777215 | 2171169 | I32 | rw | No | ALL | Yes | C | |
| 3406h | 00h | SI7 input selection | — | 0 to 16777215 | 3158064 | I32 | rw | No | ALL | Yes | C | |
| 3407h | 00h | SI8 input selection | — | 0 to 16777215 | 3223857 | I32 | rw | No | ALL | Yes | C | |
| 3410h | 00h | SO1 output selection | — | 0 to 16777215 | 197379 | I32 | rw | No | ALL | Yes | C | *“3.2.5.5.1”* |
| 3411h | 00h | SO2 output selection | — | 0 to 16777215 | 1052688 | I32 | rw | No | ALL | Yes | C | |
| 3412h | 00h | SO3 output selection | — | 0 to 16777215 | 65793 | I32 | rw | No | ALL | Yes | C | |
| 3416h | 00h | Type of analog monitor 1 | — | 0 to 35 | 0 | I16 | rw | No | ALL | Yes | A | *“3.2.8”* |
| 3417h | 00h | Analog monitor 1 output gain | — | 0 to 214748364 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3418h | 00h | Type of analog monitor 2 | — | 0 to 35 | 4 | I16 | rw | No | ALL | Yes | A | |
| 3419h | 00h | Analog monitor 2 output gain | — | 0 to 214748364 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3421h | 00h | Analog monitor output setup | — | 0 to 2 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3422h (*1) | 00h | Analog input (AIN) offset setting | 0.375 mV | -26666 to 26666 | 0 | I16 | rw | No | ALL | Yes | B | *“6.6.5.3.6”* |
| 3423h (*1) | 00h | Analog input (AIN) filter setting | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3424h (*1) | 00h | Analog input (AIN) excessive setting | 0.1 V | 0 to 100 | 0 | I16 | rw | No | ALL | Yes | B | |
| 3431h | 00h | Positioning complete (In-position) range | Command unit | 0 to 2097152 | 8400 | I32 | rw | No | csp<br>pp<br>hm<br>ip | Yes | A | *“7.3.4”*<br>OI_A |
| 3432h | 00h | Positioning complete (In-position) output setup | — | 0 to 10 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | A | *“7.3.4”* |
| 3433h | 00h | INP hold time | ms | 0 to 30000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | A | |
| 3434h | 00h | Zero-speed | r/min | 10 to 20000 | 50 | I16 | rw | No | ALL | Yes | A | *“3.2.5.5.1”* |
| 3435h | 00h | Speed coincidence range | r/min | 10 to 20000 | 50 | I16 | rw | No | csv<br>pv<br>cst<br>tq | Yes | A | *“7.4.5”* |
| 3436h | 00h | At-speed (Speed arrival) | r/min | 10 to 20000 | 1000 | I16 | rw | No | csv<br>pv<br>cst<br>tq | Yes | A | *“7.4.4”* |
| 3437h | 00h | Mechanical brake action at stalling setup | ms | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | B | *“8.13”* |
| 3438h | 00h | Mechanical brake action at running setup | ms | 0 to 32000 | 0 | I16 | rw | No | ALL | Yes | B | *“8.13”*<br>*“8.15”*<br>*“8.16”*<br>*“8.19”* |
| 3439h | 00h | Brake release speed setup | r/min | 30 to 3000 | 30 | I16 | rw | No | ALL | Yes | B | *“8.13”*<br>*“8.15”*<br>*“8.16”* |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3440h | 00h | Selection of alarm output 1 | – | 0 to 32767 | 0 | I16 | rw | No | ALL | Yes | A | *“10.3”* |
| 3441h | 00h | Selection of alarm output 2 | – | 0 to 32767 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3442h | 00h | Positioning complete (In-position) range 2 | Command unit | 0 to 2097152 | 8400 | I32 | rw | No | csp<br>pp<br>hm<br>ip | Yes | A | *“7.3.4”* |
| 3444h | 00h | Position comparison output pulse width setting | 0.1 ms | 0 to 32767 | 0 | I16 | rw | No | ALL | Yes | R | *“8.3”* |
| 3445h | 00h | Position comparison output polarity selection | – | 0 to 7 | 0 | I16 | rw | No | ALL | Yes | R | – |
| | | ● bit 0: Polarity for SO1 (general-purpose output) or OCMP1 (encoder/position comparison output terminal) | | | | | | | | | | *“8.3”* |
| | | ● bit 1: Polarity for SO2 (general-purpose output) or OCMP2 (encoder/position comparison output terminal) | | | | | | | | | | |
| | | ● bit 2: Polarity for SO3 (general-purpose output) or OCMP3 (encoder/position comparison output terminal) | | | | | | | | | | |
| 3447h | 00h | Pulse output selection | – | 0 to 1 | 0 | I16 | rw | No | ALL | Yes | R | *“8.3”*<br>*“8.6”* |
| 3448h | 00h | Position comparison value 1 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | *“8.3”* |
| 3449h | 00h | Position comparison value 2 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3450h | 00h | Position comparison value 3 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3451h | 00h | Position comparison value 4 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3452h | 00h | Position comparison value 5 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3453h | 00h | Position comparison value 6 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3454h | 00h | Position comparison value 7 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3455h | 00h | Position comparison value 8 | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | A | |
| 3456h | 00h | Position comparison output delay compensation amount | 0.1 μs | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | R | |
| 3457h | 00h | Position comparison output assignment setting | – | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | R | – |
| | | ● bit 3 to 0: Position comparison 1 | | | | | | | | | | *“8.3”* |
| | | ● bit 7 to 4: Position comparison 2 | | | | | | | | | | |
| | | ● bit 11 to 8: Position comparison 3 | | | | | | | | | | |
| | | ● bit 15 to 12: Position comparison 4 | | | | | | | | | | |
| | | ● bit 19 to 16: Position comparison 5 | | | | | | | | | | |
| | | ● bit 23 to 20: Position comparison 6 | | | | | | | | | | |
| | | ● bit 27 to 24: Position comparison 7 | | | | | | | | | | |
| | | ● bit 31 to 28: Position comparison 8 | | | | | | | | | | |
| 3463h | 00h | Reserved | – | – | 5242884 | I32 | – | – | – | – | – | – |
| 3464h | 00h | Reserved | – | – | 64 | I32 | – | – | – | – | – | – |

*1 Cannot be used with the standard type or multi-function type. Do not change the factory default value.

### 6.2.2.6 Class 5: Enhancing Settings

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3503h | 00h | Denominator of pulse output division | – | 0 to 134217728 | 0 | I32 | rw | No | ALL | Yes | R | *“8.6”* |
| 3504h | 00h | Over-travel inhibit input setup | – | 0 to 2 | 1 | I16 | rw | No | ALL | Yes | C | *“8.12”*<br>*“6.6.5.5.3”*<br>*“6.6.8.2.7”* |
| 3505h | 00h | Sequence at over-travel inhibit | – | 0 to 2 | 0 | I16 | rw | No | ALL | Yes | C | *“8.12”*<br>*“8.19”*<br>*“6.6.8.2.7”* |
| 3506h | 00h | Sequence at Servo-Off | – | 0 to 9 | 0 | I16 | rw | No | ALL | Yes | B | *“8.13”*<br>*“8.19”*<br>*“6.6.8.2”* |
| 3507h | 00h | Sequence upon main power off | – | 0 to 9 | 0 | I16 | rw | No | ALL | Yes | B | *“8.14”*<br>*“8.19”*<br>*“6.6.8.2.7”* |
| 3508h | 00h | L/V trip selection upon main power off | – | 0 to 3 | 0 | I16 | rw | No | ALL | Yes | B | – |
| | | ● bit 0: Operation selection with main power supply OFF | | | | | | | | | | *“8.10”*<br>*“8.14”*<br>*“6.6.8.2.1”* |
| | | ● bit 1: Main power off warning condition detection time | | | | | | | | | | |
| 3509h | 00h | Detection time of main power off | ms | 20 to 2000 | 2000 | I16 | rw | No | ALL | Yes | C | *“8.10”*<br>*“8.14”*<br>*“6.6.8.2.1”* |
| 3510h | 00h | Sequence at alarm | – | 0 to 7 | 0 | I16 | rw | No | ALL | Yes | B | *“8.15”*<br>*“8.16”*<br>*“8.17”*<br>*“8.19”*<br>*“6.6.8.2”* |
| 3511h | 00h | Torque setup for emergency stop | % | 0 to 500 | 0 | I16 | rw | No | ALL | Yes | B | *“8.1”*<br>*“8.12”*<br>*“8.13”*<br>*“8.14”*<br>*“8.16”*<br>*“6.6.8.2.7”* |
| 3512h | 00h | Motor over-load level setup | % | 0 to 500 | 0 | I16 | rw | No | ALL | Yes | A | *“10.3”* |
| 3513h | 00h | Over-speed level setup | r/min | 0 to 20000 | 0 | I16 | rw | No | ALL | Yes | B | *“8.16”* |
| 3514h | 00h | Motor working range setup | 0.1 rotation | 0 to 1000 | 10 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | A | *“7.2.4”* |
| 3515h | 00h | Control input signal reading setup | – | 0 to 3 | 0 | I16 | rw | No | ALL | Yes | C | *“3.2.5.4.2”* |
| 3516h | 00h | Reserved | – | – | 1 | I16 | – | – | – | – | – | – |
| 3520h | 00h | Position setup unit select | – | 0 to 1 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | C | *“7.3.4”*<br>*“7.2.9”* |
| 3521h | 00h | Selection of torque limit | – | 0 to 5 | 1 | I16 | rw | No | ALL | Yes | B | *“8.1”* |
| 3522h | 00h | 2nd torque limit | % | 0 to 500 | 500 (*1) | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | |
| 3525h | 00h | Reserved | – | – | 0 | I16 | – | – | – | – | – | – |
| 3526h | 00h | Reserved | – | – | 0 | I16 | – | – | – | – | – | – |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3529h | 00h | Reserved | — | — | 2 | I16 | — | — | — | — | — | — |
| 3531h | 00h | USB axis address | — | 0 to 127 | 1 | I16 | rw | No | ALL | Yes | C | PT_OM |
| 3533h | 00h | Pulse regenerative output limit setup | — | 0 to 1 | 0 | I16 | rw | No | ALL | Yes | C | *“8.6”* |
| 3534h | 00h | Reserved | — | — | 4 | I16 | — | — | — | — | — | — |
| 3536h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3545h | 00h | Quadrant glitch positive-direction compensation value | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3546h | 00h | Quadrant glitch negative-direction compensation value | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3547h | 00h | Quadrant glitch compensation delay time | ms | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3548h | 00h | Quadrant glitch compensation filter setting L | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3549h | 00h | Quadrant glitch compensation filter setting H | 0.1 ms | 0 to 10000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3550h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| | | | | ⋮ | | | | | | | | |
| 3555h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | |
| 3556h | 00h | Slow stop deceleration time setting | ms/<br>(1000 r/min) | 0 to 10000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S)<br>csv (S)<br>pv (S)<br>cst (S)<br>tq (S) | Yes | B | *“8.19”* |
| 3557h | 00h | Slow stop S-shape acceleration and deceleration setting | ms | 0 to 1000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S)<br>csv (S)<br>pv (S)<br>cst (S)<br>tq (S) | Yes | B | |
| 3566h | 00h | Deterioration diagnosis convergence judgment time | 0.1 s | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | A | *“8.9”* |
| 3567h | 00h | Deterioration diagnosis inertia ratio upper limit | % | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3568h | 00h | Deterioration diagnosis inertia ratio lower limit | % | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3569h | 00h | Deterioration diagnosis unbalanced load upper limit | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3570h | 00h | Deterioration diagnosis unbalanced load lower limit | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3571h | 00h | Deterioration diagnosis dynamic friction upper limit | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | ALL | Yes | A | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3572h | 00h | Deterioration diagnosis dynamic friction lower limit | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | ALL | Yes | A | *“8.9”* |
| 3573h | 00h | Deterioration diagnosis viscous friction upper limit | 0.1%/ (10000 r/min) | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3574h | 00h | Deterioration diagnosis viscous friction lower limit | 0.1%/ (10000 r/min) | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3575h | 00h | Deterioration diagnosis velocity setting | r/min | -20000 to 20000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3576h | 00h | Deterioration diagnosis torque average time | ms | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3577h | 00h | Deterioration diagnosis torque upper limit | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3578h | 00h | Deterioration diagnosis torque lower limit | 0.1% | -1000 to 1000 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3595h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 35B0h | 00h | Driver derating factor | % | 0 to 100 | 100 | I16 | rw | No | ALL | Yes | A | *“8.20”* |
| 35B2h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |

*1 Factory default values vary depending on the servo driver and motor combination.

For details, see *“8.1 Torque Limit Switching Function”* .

### 6.2.2.7 Class 6: Special Settings

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3602h | 00h | Speed deviation excess setup | r/min | 0 to 20000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | A | *“Err24.1.0”* |
| 3603h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3605h | 00h | Position 3rd gain valid time | 0.1 ms | 0 to 10000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3606h | 00h | Position 3rd gain scale factor | % | 50 to 1000 | 100 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3607h | 00h | Torque command additional value | % | -100 to 100 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | OI_A |
| 3608h | 00h | Positive direction torque compensation value | % | -100 to 100 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3609h | 00h | Negative direction torque compensation value | % | -100 to 100 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3610h | 00h | Function expansion setup | — | -32768 to 32767 | 528 | I16 | rw | No | ALL | Yes | B | — |
| | | ● bit 1: Load fluctuation control function | | | | | | | | | | OI_A |
| | | ● bit 2: Load fluctuation stabilization setting | | | | | | | | | | |
| | | ● bit 4: Current response improvement | | | | | | | | | | OI_A |
| | | ● bit 10: Fall prevention function during an alarm | | | | | | | | | | *“8.17”*<br>*“8.19”* |
| | | ● bit 11: Encoder overheat error protection detection | | | | | | | | | | *“Err15.1.0”* |
| | | ● bit 14: Load fluctuation suppression function automatic tuning | | | | | | | | | | OI_A |
| | | ● bit 15: Slow stop function | | | | | | | | | | *“8.19”* |
| 3611h | 00h | Current loop gain response setup | % | 10 to 300 | 100 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3614h | 00h | Emergency stop time at alarm | ms | 0 to 1000 | 200 | I16 | rw | No | ALL | Yes | B | *“8.16”*<br>*“8.19”* |
| 3615h | 00h | 2nd over-speed level setup | r/min | 0 to 20000 | 0 | I16 | rw | No | ALL | Yes | B | *“8.16”* |
| 3618h | 00h | Power-up wait time | 100 ms | 0 to 100 | 0 | I16 | rw | No | ALL | Yes | R | *“3.4.4”*<br>*“7.1”* |
| 3619h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3620h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3621h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3622h | 00h | AB phase external scale pulse outputting method selection | — | 0 to 1 | 0 | I16 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | R | *“8.6”* |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3623h | 00h | Load change compensation gain | % | -100 to 100 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | OI_A |
| 3624h | 00h | Load change compensation filter | 0.01 ms | 10 to 2500 | 53 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | |
| 3626h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3627h | 00h | Warning latch state setup | — | 0 to 3 | 3 | I16 | rw | No | ALL | Yes | C | — |
| | | ● bit 0: Expanded warnings | | | | | | | | | | *“10.3”* |
| | | ● bit 1: General warnings | | | | | | | | | | |
| 3630h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3631h | 00h | Real time auto tuning estimation speed | — | 0 to 3 | 1 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3632h | 00h | Real time auto tuning custom set-up | — | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | B | — |
| | | ● bit 1 to 0: Load characteristics estimation | | | | | | | | | | OI_A |
| | | ● bit 3 to 2: Inertia Ratio Update | | | | | | | | | | |
| | | ● bit 6 to 4: Torque compensation | | | | | | | | | | |
| | | ● bit 7: Stiffness Setup | | | | | | | | | | |
| | | ● bit 8: Fixed Parameter Setup | | | | | | | | | | |
| | | ● bit 10 to 9: Gain Switching Setup | | | | | | | | | | |
| | | ● bit 11: Torque compensation setting switching | | | | | | | | | | |
| | | ● bit 15 to 12: Individual torque compensation settings | | | | | | | | | | |
| 3634h | 00h | Hybrid vibration suppression gain | $0.1\ s^{-1}$ | 0 to 30000 | 0 | I16 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | B | OI_A |
| 3635h | 00h | Hybrid vibration suppression filter | 0.01 ms | 0 to 32000 | 10 | I16 | rw | No | csp (F)<br>pp (F)<br>hm (F)<br>ip (F) | Yes | B | |
| 3636h | 00h | Dynamic brake operation input setup | — | 0 to 1 | 0 | I16 | rw | No | ALL | Yes | R | *“8.14”* |
| 3637h | 00h | Oscillation detecting level | 0.1% | 0 to 1000 | 0 | I16 | rw | No | ALL | Yes | B | *“10.3”* |
| 3638h | 00h | Warning mask setup | — | -32768 to 32767 | 4 | I16 | rw | No | ALL | Yes | C | |
| 3639h | 00h | Warning mask setup 2 | — | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | C | |
| 3641h | 00h | 1st damping depth | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3642h | 00h | 2-stage torque filter time constant | 0.01 ms | 0 to 2500 | 0 | I16 | rw | No | ALL | Yes | B | OI_A |
| 3643h | 00h | 2-stage torque filter attenuation term | — | 0 to 1000 | 1000 | I16 | rw | No | ALL | Yes | B | |
| 3647h | 00h | Function expansion setup 2 | — | -32768 to 32767 | 1 | I16 | rw | No | ALL | Yes | R | — |
| | | ● bit 0: Two-degree-of-freedom control mode | | | | | | | | | | *“7.2.5”*<br>OI_A |
| | | ● bit 2: Encoder communication error/warning judgment setup | | | | | | | | | | *“10.3”* |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3647h | 00h | ● bit 3: Two-degree-of-freedom control real-time auto tuning selection | | | | | | | | | | *“7.2.5”*<br>OI_A |
| | | ● bit 14: Quadrant glitch compensation function | | | | | | | | | | OI_A |
| 3648h | 00h | Tuning filter | 0.1 ms | 0 to 2000 | Size A: 11<br>Size B: 12<br>Sizes C, D: 17 (12) (*1) | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | *“7.3.2”*<br>*“7.4.2”*<br>*“7.6.2”* |
| 3649h | 00h | Command/tuning filter damping | — | 0 to 99 | 15 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | *“7.3.2”*<br>*“7.4.2”*<br>*“7.6.2”*<br>OI_A |
| 3650h | 00h | Viscous friction compensating gain | 0.1%/ (10000 r/min) | 0 to 10000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | *“7.3.2”*<br>*“7.6.2”*<br>OI_A |
| 3651h | 00h | Wait time for emergency stop | ms | 0 to 10000 | 0 | I16 | rw | No | ALL | Yes | B | *“8.17”* |
| 3652h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| ⋮ | | | | | | | | | | | | |
| 3654h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | |
| 3657h | 00h | Torque saturation error protection detection time | ms | 0 to 5000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | *“8.2”* |
| 3658h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3659h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3660h | 00h | 2nd damping depth | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3661h | 00h | 1st resonance frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | OI_A |
| 3662h | 00h | 1st resonance attenuation ratio | — | 0 to 1000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3663h | 00h | 1st anti-resonance frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3664h | 00h | 1st anti-resonance attenuation ratio | — | 0 to 1000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3665h | 00h | 1st response frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3666h | 00h | 2nd resonance frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | OI_A |
| 3667h | 00h | 2nd resonance attenuation ratio | — | 0 to 1000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3668h | 00h | 2nd anti-resonance frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3669h | 00h | 2nd anti-resonance attenuation ratio | — | 0 to 1000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3670h | 00h | 2nd response frequency | 0.1 Hz | 0 to 3000 | 0 | I16 | rw | No | csp (S)<br>pp (S)<br>hm (S)<br>ip (S) | Yes | B | |
| 3671h | 00h | 3rd damping depth | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3672h | 00h | 4th damping depth | — | 0 to 1000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3673h | 00h | Load estimation filter | 0.01 ms | 0 to 2500 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | OI_A |
| 3674h | 00h | Torque compensation frequency 1 | 0.1 Hz | 0 to 5000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | |
| 3675h | 00h | Torque compensation frequency 2 | 0.1 Hz | 0 to 5000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | |
| 3676h | 00h | Load estimation count | — | 0 to 8 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | |
| 3685h | 00h | Retracting operation condition setting | — | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | C | — |
| | | ● bits 3 to 0: Non-communication settings | | | | | | | | | | *“8.10”* |
| | | ● bits 7 to 4: Communication-related setting | | | | | | | | | | |
| | | ● bits 9 to 8: Judgment condition for stopping retracting operation | | | | | | | | | | |
| 3686h | 00h | Retracting operation alarm setting | — | 0 to 7 | 0 | I16 | rw | No | ALL | Yes | C | — |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3686h | 00h | ● bit 0: Err87.1.0 “Retracting operation completion (I/O)” | | | | | | | | | | *“8.10”* |
| | | ● bit 1: Err87.2.0 “Retracting operation completion (communication)” | | | | | | | | | | |
| | | ● bit 2: Err87.3.0 “Retracting operation error” | | | | | | | | | | |
| 3687h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3688h | 00h | Absolute encoder multi-turn data upper-limit value | — | 0 to 65534 | 0 | I32 | rw | No | ALL | Yes | C | *“8.5”* |
| 3695h | 00h | Motor over-load warning detection level | % | 0 to 114 | 0 | I16 | rw | No | ALL | Yes | A | *“10.3”* |
| 3696h | 00h | Motor over-load warning release level | % | 0 to 114 | 0 | I16 | rw | No | ALL | Yes | A | |
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | B | — |
| | | ● bit 0: Quadrant glitch compensation HPF clear | | | | | | | | | | OI_A |
| | | ● bit 1: Deterioration Diagnosis Warning Function | | | | | | | | | | *“8.9”*<br>*“10.3”* |
| | | ● bit 2: Motor movable range error protection expansion | | | | | | | | | | *“7.2.4”* |
| | | ● bit 3: Selection of external scale single-turn data monitor | | | | | | | | | | *“7.6.6”* |
| | | ● bit 6: Switches position information during backlash correction | | | | | | | | | | OI_A |
| | | ● bit 8: Target control mode extension of Obj.607Fh:00h “Max profile velocity” | | | | | | | | | | *“6.6.5.1.1.2”*<br>*“6.6.6.2.1.2”*<br>*“6.6.7.1.1.1”* |
| | | ● bit 11: External scale position latch during semi-closed control | | | | | | | | | | *“6.6.8.1”* |
| | | ● bit 12: Speed limit priority function during torque control | | | | | | | | | | *“7.5.2”*<br>*“6.6.7.3.1.2”* |
| | | ● bit 13: Touch probe latch completion status toggle output enabled | | | | | | | | | | *“6.6.8.1”* |
| | | ● bit 14: Over-travel inhibit warning | | | | | | | | | | *“10.3”* |
| | | ● bit 27: Alarm display switch setting | | | | | | | | | | *“3.4.3”* |
| 3698h | 00h | Function expansion setup 4 | — | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | R | — |
| | | ● bit 3: Effective bit expansion for multi-turn data | | | | | | | | | | *“8.5”*<br>*“6.6.8.4.4”* |
| | | ● bit 8: Control mode switch function expansion | | | | | | | | | | *“6.6.5.5.1.3”* |
| | | ● bit 10: Selection of external scale single-turn data output format | | | | | | | | | | *“7.6.6”* |
| | | ● bit 21: Expand conditions for canceling over-travel inhibit | | | | | | | | | | *“8.12”* |
| 36A0h | 00h | Reserved | — | — | 4000 | I16 | — | — | — | — | — | — |
| 36A1h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 36A2h | 00h | Over-travel inhibit release level setup | Command unit | 0 to 2147483647 | 0 | I32 | rw | No | csp | Yes | B | *“8.12”*<br>*“6.6.8.2.7”* |
| 36A4h | 00h | Open-phase monitoring setup | — | 0 to 3 | 0 | I16 | rw | No | ALL | Yes | B | *“10.3”*<br>*“Err13.2.0”* |
| 36A6h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 36C1h | 00h | Current feed forward response setup | % | 0 to 300 | 100 | I16 | rw | No | ALL | Yes | B | OI_A |
| 36C5h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 36C6h | 00h | Warning2 mask setup | — | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | C | *“10.3”* |
| 36C7h | 00h | Warning3 mask setup | — | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | C | |

*1 Values in parentheses are initial values for models with an instantaneous maximum current (peak value) of less than 24 A.

### 6.2.2.8 Class 7: Special Settings 2

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3700h | 00h | Display on LED | — | 0 to 32767 | 0 | I16 | rw | No | ALL | Yes | A | TR_FS “3.4.1” |
| 3701h | 00h | Display time setup upon power-up | 100 ms | 0 to 1000 | 0 | I16 | rw | No | ALL | Yes | R | |
| 3703h | 00h | Output setup during torque limit | — | 0 to 1 | 0 | I16 | rw | No | cst<br>tq | Yes | A | *“8.2”*<br>*“6.6.3”* |
| 3704h | 00h | Backlash compensation enable | — | 0 to 7 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | — |
| | | ● bits 1 to 0: Enable or disable backlash compensation and select the direction of operation during compensation | | | | | | | | | | OI_A |
| | | ● bit 2: Expand backlash compensation retention conditions | | | | | | | | | | |
| 3705h | 00h | Backlash compensation value | pulse | -1073741824 to 1073741823 | 0 | I32 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3706h | 00h | Constant for backlash compensation | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | |
| 3707h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3708h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3709h | 00h | Correction time of latch delay 1 | 25 ns | -2000 to 2000 | 360 | I16 | rw | No | ALL | Yes | B | *“6.6.8.1.8”* |
| 3710h | 00h | Reserved | — | — | 3 | I16 | — | — | — | — | — | — |
| 3711h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| ⋮ | | | | | | | | | | | | |
| 3713h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | |
| 3714h | 00h | Main power off warning detection time | ms | 0 to 2000 | 0 | I16 | rw | No | ALL | Yes | C | *“10.3”* |
| 3715h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3716h | 00h | Torque saturation error protection frequency | Incidences | 0 to 30000 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | *“8.2”* |
| 3718h | 00h | Backlash compensation value holding range | Command unit | 0 to 2147483647 | 0 | I32 | rw | No | csp<br>pp<br>hm<br>ip | Yes | B | OI_A |
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | R | — |
| | | ● bit 4: External scale position information monitoring function setting for semi-closed control | | | | | | | | | | *“8.8”* |
| | | ● bit 5: Command position change saturation function selection | | | | | | | | | | *“6.6.5.3.1.3”*<br>*“6.6.5.3.5”* |
| | | ● bit 6: Homing return velocity limit enabled | | | | | | | | | | *“6.6.5.5.3”* |
| | | ● bit 7: Over-travel inhibit input detection setting during Z-phase homing return operation | | | | | | | | | | |
| | | ● bit 11: LINK establishment mode selection | | | | | | | | | | *“3.4.4”* |
| 3723h | 00h | Communication function extended setup 2 | — | -32768 to 32767 | 16384 | I16 | rw | No | ALL | Yes | B | — |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3723h | 00h | ● bit 14: Position deviation [command unit] output setup | | | | | | | | | | *"7.3.4"*<br>*"7.3.2"*<br>*"7.3.3"*<br>*"7.6.2"*<br>*"7.6.3"* |
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | 14352 | I16 | rw | No | ALL | Yes | C | — |
| | | ● bit 0: EX-OUT1 output status setting at the time of communication interrupted after EtherCAT communication is established | | | | | | | | | | *"3.2.5.5.1"*<br>*"6.6.8.3.2"* |
| | | ● bit 5: Latch position detection delay compensation function switching | | | | | | | | | | *"6.6.8.1.8"* |
| | | ● bit 7: TFF clear ON/OFF selection from host device | | | | | | | | | | *"8.18"*<br>*"6.6.5.1.1.6"*<br>*"6.6.6.1.1.3"* |
| | | ● bit 11: Condition setting for Obj.6041h: bit 12 "drive follows command value" | | | | | | | | | | *"6.6.5.3.1.3"*<br>*"6.6.5.3.2.2"*<br>*"6.6.6.3.1.2"*<br>*"6.6.6.3.2.1"*<br>*"6.6.7.3.1.2"*<br>*"6.6.7.3.2.1"* |
| 3739h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3740h | 00h | Station Alias setup (high) | — | 0 to 255 | 0 | I16 | rw | No | ALL | Yes | R | *"4.2.5"* |
| 3741h | 00h | Station Alias selection | — | 0 to 2 | 1 | I16 | rw | No | ALL | Yes | R | |
| 3742h | 00h | Maximum continuation communication error | — | -32768 to 32767 | -30584 | I16 | rw | No | ALL | Yes | R | — |
| | | ● bits 3 to 0: Err80.7.0 detection threshold | | | | | | | | | | *"Err80.3.0"*<br>*"Err80.7.0"* |
| 3743h | 00h | Lost link detection time | ms | 0 to 32767 | 0 | I16 | rw | No | ALL | Yes | R | *"Err85.2.0"* |
| 3744h | 00h | Software version | — | -2147483648 to 2147483647 | 16908546 | I32 | ro | No | ALL | Yes | X | *"6.3.1"* |
| 3779h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3780h | 00h | Communication function extended setup 8 | — | -32768 to 32767 | 2048 | I16 | rw | No | ALL | Yes | C | — |
| | | ● bit 6: Obj.6041h:00h "Statusword" : bit 12 Expansion setup for "homing attained" | | | | | | | | | | *"6.6.5.5.3"* |
| 3787h | 00h | Communication function extended setup 5 | — | -32768 to 32767 | 3072 | I16 | rw | No | ALL | Yes | C | — |
| 3792h | 00h | Correction time of latch delay 2 | 25 ns | -2000 to 2000 | 0 | I16 | rw | No | ALL | Yes | B | *"6.6.8.1.8"* |
| 3793h | 00h | Homing return speed limit value | r/min | 0 to 20000 | 0 | I16 | rw | No | hm | Yes | C | *"6.6.5.5.3"* |
| 3799h | 00h | Communication function extended setup 6 | — | -32768 to 32767 | 0 | I16 | rw | No | ALL | Yes | B | — |
| | | ● bit 0: Enable/disable FFT execution while EtherCAT communication is established | | | | | | | | | | *"10.3"*<br>*"4.2.4"* |
| | | ● bit 3: Command pulse accumulated value [command unit] output setting | | | | | | | | | | *"7.3.2"*<br>*"7.3.3"*<br>*"7.6.2"*<br>*"7.6.3"* |
| 37A0h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| | | ⋮ | | | | | | | | | | |
| 37A4h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | |
| 37A8h | 00h | Reserved | — | — | 7 | I16 | — | — | — | — | — | — |
| 37A9h | 00h | Reserved | — | — | 1 | I16 | — | — | — | — | — | — |
| 37B0h | 00h | Communication function extended setup 7 | — | -2147483648 to 2147483647 | 384 | I32 | rw | No | ALL | Yes | B | — |
| | | ● bit 7: Err80.7.0 detection function expansion | | | | | | | | | | *"Err80.7.0"* |
| | | ● bit 8: Err80.3.0 detection function expansion | | | | | | | | | | *"Err80.3.0"* |
| | | ● bit 12: ERR Indicator off specification expansion | | | | | | | | | | *"3.4.4"* |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37B3h | 00h | Torque offset filter | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | csp<br>pp<br>hm<br>ip<br>csv<br>pv | Yes | B | *“7.3.2”*<br>*“7.3.3”*<br>*“7.4.2”*<br>*“7.4.3”*<br>*“7.6.2”*<br>*“7.6.3”*<br>*“8.18”* |
| 37B7h | 00h | Reserved | — | -2147483648～2147483647 | 0 | I32 | — | — | — | — | — | — |
| 37C0h | 00h | Absolute scale offset1 | Rotation (multi-turn data),<br>or pulse (external scale upper 32 bits) | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | R | *“6.6.5.5.1.1”* |
| 37C1h | 00h | Absolute scale offset2 | pulse (single-turn data),<br>or pulse (external scale lower 32 bits) | -2147483648 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | R | *“6.6.5.5.1.2”* |
| 37C7h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |

### 6.2.2.9 Class 8: Special Settings 3

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3800h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3801h | 00h | Profile linear acceleration constant | 10,000 command units/s$^2$ | 1 to 429496 | 1 | I32 | rw | No | ALL | Yes | B | *“8.10”* |
| 3802h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3803h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3804h | 00h | Profile linear deceleration constant | 10,000 command units/s$^2$ | 1 to 429496 | 1 | I32 | rw | No | ALL | Yes | B | *“8.10”* |
| 3805h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3810h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3812h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3813h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| ⁝ | | | | | | | | | | | | |
| 3815h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | |
| 3817h | 00h | Relative movement of retracting operation | Command unit | -2147483647 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | B | *“8.10”* |
| 3818h | 00h | Retracting operation speed | Command unit/s | 0 to 2147483647 | 0 | I32 | rw | No | ALL | Yes | B | |
| 3819h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |

### 6.2.2.10 Class 9: Linear Relationship

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3901h | 00h | Feedback scale resolution / Number of scale pulses per rotation | pulse | 0 to 536870912 | 0 | I32 | rw | No | ALL | Yes | R | *“7.6.6”* |

### 6.2.2.11 Class 10: Special Settings 4

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3A00h | 00h | Reserved | — | — | — | I16 | — | — | — | — | — | — |
| 3A01h | 00h | Reserved | — | 0～4 | 0 | I16 | — | — | — | — | — | — |

### 6.2.2.12 Class 11: Manufacturer Use

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3B00h | 00h | Reserved | — | — | 1 | I16 | — | — | — | — | — | — |
| 3B01h | 00h | Reserved | — | — | 503578880 | I32 | — | — | — | — | — | — |
| 3B02h | 00h | Reserved | — | — | 658185 | I32 | — | — | — | — | — | — |
| 3B03h | 00h | Reserved | — | — | -1 | I32 | — | — | — | — | — | — |
| ⋮ | | | | | | | | | | | | |
| 3B06h | 00h | Reserved | — | — | -1 | I32 | — | — | — | — | — | |
| 3B07h | 00h | Reserved | — | — | 16 | I16 | — | — | — | — | — | — |
| 3B08h | 00h | Reserved | — | — | 6 | I16 | — | — | — | — | — | — |
| 3B09h | 00h | Reserved | — | — | 1 | I16 | — | — | — | — | — | — |
| 3B10h | 00h | Reserved | — | — | 129 | I16 | — | — | — | — | — | — |
| 3B11h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B12h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3B13h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B14h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B15h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3B16h | 00h | Reserved | — | — | 255 | I16 | — | — | — | — | — | — |
| 3B17h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B18h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3B19h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B20h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B21h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| 3B22h | 00h | Reserved | — | — | 0 | I16 | — | — | — | — | — | — |
| 3B23h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | — |
| ⋮ | | | | | | | | | | | | |
| 3B26h | 00h | Reserved | — | — | 0 | I32 | — | — | — | — | — | |

## 6.2.3 User-specific Area (4000h to 4FFFh)

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4304h | 00h | Touch probe function expansion setup | – | 0 to 65535 | 0 | U16 | rw | RxPDO | ALL | Yes | B | – |
| | | ● bit 0: Touch probe 1 External scale position latch Z-phase switching in semi-closed control | | | | | | | | | | *"6.6.8.1.9"* |
| | | ● bit 1: Touch probe 1 Change storage location of external scale feedback position in semi-closed control | | | | | | | | | | |
| | | ● bit 8: Touch probe 2 External scale position latch Z-phase switching in semi-closed control | | | | | | | | | | |
| | | ● bit 9: Touch probe 2 Change storage location of external scale feedback position in semi-closed control | | | | | | | | | | |
| 4308h | 00h | History number | – | 0 to 3 | 0 | U8 | rw | No | ALL | No | A | *"6.6.8.7"* |
| 430Eh | – | Timestamp reference time | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 2 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Timestamp reference time setting 1 | ns | 0 to 4294967295 | 0 | U32 | rw | No | ALL | No | A | |
| | 02h | Timestamp reference time setting 2 | ns | 0 to 4294967295 | 0 | U32 | rw | No | ALL | No | A | |
| 4310h | 00h | Alarm main no | – | 0 to 127 | 0 | U8 | rw | No | ALL | No | A | |
| 4311h | 00h | Reserved | – | – | – | U8 | – | – | – | – | – | – |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | 0 | U16 | rw | RxPDO | ALL | No | A | *"6.6.5.1.1.3"*<br>*"6.6.6.1.1.2"*<br>*"6.6.7.1.1.2"*<br>*"6.6.8.3.2"* |
| 4314h (*1) | 00h | Analog input internal offset | mV | -32768 to 32767 | 0 | I16 | rw | RxPDO | ALL | Yes | A | *"6.6.5.3.6.1"* |
| 4315h (*1) | 00h | Analog input deviation limit | mV | 0 to 65535 | 0 | U16 | rw | RxPDO | ALL | Yes | A | |
| 4316h (*1) | – | Analog input voltage setup | – | – | – | – | – | – | – | – | – | |
| | 00h | Number of entries | – | 1 | – | U8 | ro | No | csp | No | X | |
| | 01h | Analog input voltage dead zone | mV | 0 to 65535 | 0 | U16 | rw | RxPDO | ALL | Yes | B | |
| 4317h | 00h | Alarm sub no | – | 0 to 127 | 0 | U8 | rw | No | ALL | No | A | *"6.6.8.7"* |
| 4320h (*5) | 00h | Analog monitor output 1 | – | -32768 to 32767 | 0 | I16 | rw | RxPDO | ALL | No | A | – |
| 4321h (*5) | 00h | Analog monitor output 2 | – | -32768 to 32767 | 0 | I16 | rw | RxPDO | ALL | No | A | – |
| 4351h (*5) | 00h | Analog input function | – | 0 to 65535 | 0 | U16 | rw | RxPDO | csp | Yes | B | – |
| | | ● bit 0: Displacement control function switch | | | | | | | | | | *"6.6.5.3.6.1"* |
| | | ● bit 1: Position command latch switch | | | | | | | | | | |
| 4C00h (*1) | – | Analog servo parameters | – | – | – | – | – | – | – | – | – | *"6.6.5.3.6.1"* |
| | 00h | Number of entries | – | 7 | – | U8 | ro | No | csp | No | B | |
| | 01h | Analog input gain | Command unit/mV | 0 to 30000 | 0 | I16 | rw | No | csp | Yes | B | |
| | 02h | Analog input polarity | – | 0 to 1 | 0 | I16 | rw | No | csp | Yes | B | |
| | 03h | Analog input integration time constant | 0.01 ms | 0 to 100000 | 0 | I32 | rw | No | csp | Yes | B | |
| | 04h | Analog input integration limit | Command unit | 0 to 2147483647 | 0 | I32 | rw | No | csp | Yes | B | |
| | 05h | Analog input (AIN) offset setting | 0.375 mV | -26666 to 26666 | 0 | I16 | rw | No | ALL | Yes | B | |
| | 06h | Analog input (AIN) filter setting | 0.01 ms | 0 to 6400 | 0 | I16 | rw | No | ALL | Yes | B | |
| | 07h | Analog input (AIN) excessive setting | 0.1 V | 0 to 100 | 0 | I16 | rw | No | ALL | Yes | B | |
| 4D00h | – | Special function start | – | – | – | – | – | – | – | – | – | *"6.6.8.4.4"* |
| | 00h | Number of entries | – | 3 | – | U8 | ro | No | ALL | No | X | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4D00h | 01h | Special function start flag 1 | — | 0 to 4294967295 | 0 | U32 | rw | No | ALL | No | B | — |
| | | ● bit 9: Special function start trigger | | | | | | | | | | *“6.6.8.4.4”* |
| | 02h | Special function start flag 2 | — | 0 to 4294967295 | 0 | U32 | rw | No | ALL | No | B | |
| | 03h | Reserved | — | — | 0 | U32 | rw | — | — | — | — | — |
| 4D01h | 00h | Special function setting 9 | — | 0 to 65535 | 0 | U16 | rw | No | ALL | No | B | *“6.6.8.4.4”* |
| 4D0Eh | — | Expansion warning flags | — | — | — | — | — | — | — | — | — | *“6.6.8.7”* |
| | 00h | Number of entries | — | 3 | — | U8 | ro | No | ALL | No | X | |
| | 01h | Expansion warning flags 1 | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 02h | Expansion warning flags 2 | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 03h | Expansion warning flags 3 | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| 4D0Fh | 00h | Reserved | — | — | — | U16 | — | — | — | — | — | — |
| 4D10h | — | External scale ID | — | — | — | — | — | — | — | — | — | *“6.6.8.7”* |
| | 00h | Number of entries | — | 2 | — | U8 | ro | No | ALL | No | X | |
| | 01h | External scale vendor ID | — | — | — | VS | ro | No | ALL | No | X | |
| | 02h | External scale model ID | — | — | — | VS | ro | No | ALL | No | X | |
| 4D11h | — | Reserved | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 13 | — | U8 | — | — | — | — | — | — |
| | 01h | Reserved 1 | — | — | — | U32 | — | — | — | — | — | — |
| | | ⋮ | | | | | | | | | | |
| | 0Dh | Reserved 13 | — | — | — | U32 | — | — | — | — | — | |
| 4D12h | 00h | Motor serial number | — | — | — | VS | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4D13h | 00h | Reserved | — | — | — | VS | — | — | — | — | — | — |
| 4D14h | 00h | Reserved | — | — | — | VS | — | — | — | — | — | — |
| 4D15h | 00h | Drive serial number | — | — | — | VS | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | — | U16 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.4”*<br>*“6.6.6.1.2.3”*<br>*“6.6.7.1.2.3”*<br>*“6.6.8.7”* |
| 4D35h | — | Reserved | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 | — | U8 | — | — | — | — | — | — |
| | 01h | Reserved 1 | — | — | — | U16 | — | — | — | — | — | — |
| | 02h | Reserved 2 | — | — | — | U16 | — | — | — | — | — | — |
| 4D36h | — | Reserved | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 | — | U8 | — | — | — | — | — | — |
| | 01h | Reserved 1 | — | — | — | U16 | — | — | — | — | — | — |
| | 02h | Reserved 2 | — | — | — | U16 | — | — | — | — | — | — |
| 4D51h (*2) | 00h | Analog input status | — | 0 to 65535 | — | U16 | ro | TxPDO | csp | No | X | *“6.6.5.3.6.1”*<br>*“6.6.8.7”* |
| 4D52h | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4D53h | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4D54h | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4D55h | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4D57h | 00h | Driver derating monitor | % | 0 to 65535 | — | U16 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4DA0h (*3) | — | Alarm accessory information | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 71 | — | U8 | ro | No | ALL | No | X | *“6.6.8.7”* |
| | 01h | History number echo | — | 0 to 3 | — | U8 | ro | No | ALL | No | X | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h<br>(*3) | 02h | Alarm code | — | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | “6.6.8.7” |
| | 03h | Control mode | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 04h | Motor speed | r/min | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 05h | Positional command velocity | r/min | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 06h | Velocity control command | r/min | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 07h | Torque command | 0.05% | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 08h | Position command deviation | Command unit | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 09h | Position actual internal value | pulse | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 0Ah | Reserved 10 | — | — | — | I32 | — | — | — | — | — | — |
| | 0Bh | Input port (logic signal) | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | “6.6.8.7” |
| | 0Ch | Output port (logic signal) | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 0Dh | Analog input | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 0Eh | Reserved 14 | — | — | — | I32 | — | — | — | — | — | — |
| | 0Fh | Reserved 15 | — | — | — | I32 | — | — | — | — | — | — |
| | 10h | Overload ratio | 0.2 % | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | “6.6.8.7” |
| | 11h | Regenerative load ratio | % | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 12h | Voltage across PN | V | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 13h | Temperature of amplifier | °C | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 14h | Warning flags | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 15h | Inertia ratio | % | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 16h | Reserved 22 | — | — | — | I32 | — | — | — | — | — | — |
| | ⋮ | | | | | | | | | | | |
| | 18h | Reserved 24 | — | — | — | I32 | — | — | — | — | — | |
| | 19h | Temperature of encoder | °C | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | “6.6.8.7” |
| | 1Ah | Reserved 26 | — | — | — | I32 | — | — | — | — | — | — |
| | ⋮ | | | | | | | | | | | |
| | 1Ch | Reserved 28 | — | — | — | I32 | — | — | — | — | — | |
| | 1Dh | U-phase current detection value | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | “6.6.8.7” |
| | 1Eh | W-phase current detection value | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 1Fh | Reserved 31 | — | — | — | I32 | — | — | — | — | — | — |
| | 20h | Reserved 32 | — | — | — | I32 | — | — | — | — | — | — |
| | 21h | Encoder single-turn data | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | “6.6.8.7” |
| | 22h | Encoder communication error count (accumulated) | Incidences | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | 23h | External scale communication data error count (accumulated) | Incidences | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h<br>(*3) | 24h | Reserved 36 | — | — | — | I32 | — | — | — | — | — | — |
| | 25h | Alarm occurrence time on timestamp standard (Lower) | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | *"6.6.8.7"* |
| | 26h | Alarm occurrence time on timestamp standard (Higher) | ns | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 27h | Alarm occurrence time on power on time | 0.5 h | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 28h | Alarm occurrence time on power on time (detail) | 62.5 μs | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 29h | Reserved 41 | — | — | — | U32 | — | — | — | — | — | — |
| | 2Ah | Alarm code (extended) | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | *"6.6.8.7"* |
| | 2Bh | Warning flags1 | — | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 2Ch | Warning flags2 | — | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 2Dh | Warning flags3 | — | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 2Eh | Reserved 46 | — | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | — |
| | ⋮ | | | | | | | | | | | |
| | 3Dh | Reserved 61 | — | 0 to 4294967295 | — | U32 | ro | No | ALL | No | X | |
| | 3Eh | Reserved 62 | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| | ⋮ | | | | | | | | | | | |
| | 47h | Reserved 71 | — | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| 4DB0h | — | Reserved | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 8 | — | U8 | — | — | — | — | — | — |
| | 02h | Reserved 2 | — | — | — | U32 | — | — | — | — | — | — |
| | 08h | Reserved 8 | — | — | — | U32 | — | — | — | — | — | — |
| 4F01h | 00h | Following error actual value (after filtering) | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | *"6.6.5.1.2.1"*<br>*"6.6.8.7"* |
| 4F03h<br>(*2) | 00h | Analog input internal voltage | mV | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | *"6.6.5.3.6.1"*<br>*"6.6.8.7"* |
| 4F04h | 00h | Position command internal value (after filtering) | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | *"6.6.5.1.2.1"*<br>*"6.6.8.7"* |
| 4F0Bh | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4F0Ch | 00h | Velocity command value (after filtering) | r/min | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | *"6.6.5.1.2.3"*<br>*"6.6.8.7"* |
| 4F0Dh | 00h | External scale position | pulse<br>(External scale) | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | *"6.6.5.1.2.1"*<br>*"6.6.6.1.2.1"*<br>*"6.6.7.1.2.1"*<br>*"6.6.8.7"* |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | *"6.6.5.1.2.4"*<br>*"6.6.6.1.2.3"*<br>*"6.6.7.1.2.3"*<br>*"6.6.8.7"* |
| 4F21h | 00h | Logical input signal | — | 0 to 4294967295 | — | U32 | ro | TxPDO | ALL | No | X | *"6.6.8.7"* |
| 4F22h | 00h | Logical output signal | — | 0 to 4294967295 | — | U32 | ro | TxPDO | ALL | No | X | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4F23h | 00h | Logical input signal (expansion portion) | – | 0 to 4294967295 | – | U32 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4F24h | 00h | Reserved | – | – | – | U32 | – | – | – | – | – | – |
| 4F25h | 00h | Physical input signal | – | 0 to 4294967295 | – | U32 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4F26h | 00h | Physical output signal | – | 0 to 4294967295 | – | U32 | ro | TxPDO | ALL | No | X | |
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.4”*<br>*“6.6.6.1.2.3”*<br>*“6.6.7.1.2.3”*<br>*“6.6.8.7”* |
| 4F32h | 00h | Motor automatic identification | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4F33h | 00h | Cause of motor no work | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F34h | 00h | Warning flags | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F36h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F37h | – | Multiple alarm/warning information | – | – | – | – | – | – | – | – | – | *“6.6.8.7”* |
| | 00h | Number of entries | – | 35 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Multiple alarm information 1 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 02h | Multiple alarm information 2 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 03h | Multiple alarm information 3 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 04h | Multiple alarm information 4 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 05h | Reserved 5 | – | – | – | I32 | – | – | – | – | – | – |
| | ⋮ | | | | | | | | | | | |
| | 0Fh | Reserved 15 | – | – | – | I32 | – | – | – | – | – | |
| | 10h | Multiple sub alarm information | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| | 11h | Multiple warning information 1 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 12h | Multiple warning information 2 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 13h | Multiple warning information 3 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 14h | Reserved 20 | – | – | – | I32 | – | – | – | – | – | – |
| | ⋮ | | | | | | | | | | | |
| | 1Fh | Reserved 31 | – | – | – | I32 | – | – | – | – | – | |
| | 20h | Multiple alarm cause information 1 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| | 21h | Multiple alarm cause information 2 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 22h | Multiple alarm cause information 3 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| | 23h | Multiple alarm cause information 4 | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F41h | – | Motor encoder data | – | – | – | – | – | – | – | – | – | *“6.6.5.1.2.1”*<br>*“6.6.6.1.2.1”*<br>*“6.6.7.1.2.1”*<br>*“6.6.8.7”* |
| | 00h | Number of entries | – | 2 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.5.1.2.1”*<br>*“6.6.6.1.2.1”*<br>*“6.6.7.1.2.1”*<br>*“6.6.8.7”* |
| 4F44h | 00h | Encoder status | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4F46h | 00h | Reserved | – | – | – | U16 | – | – | – | – | – | – |
| 4F48h | 00h | External scale pulse total | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.1”*<br>*“6.6.6.1.2.1”*<br>*“6.6.7.1.2.1”*<br>*“6.6.8.7”* |
| 4F49h | 00h | External scale absolute position | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F4Ah | 00h | External scale position deviation | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | *“6.6.8.7”* |
| 4F4Bh | 00h | Touch probe external scale 1 positive edge | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.8.1.5”* |
| 4F4Ch | 00h | Touch probe external scale 1 negative edge | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F4Dh | 00h | Touch probe external scale 2 positive edge | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F4Eh | 00h | Touch probe external scale 2 negative edge | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F4Fh<br>(*2) | 00h | Analog input value | Command unit | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | csp | No | X | *“6.6.5.3.6.1”*<br>*“6.6.8.7”* |
| 4F51h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F53h | 00h | Reserved | – | – | – | U32 | – | – | – | – | – | – |
| 4F61h | 00h | Power on cumulative time | 30 minutes | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4F62h | 00h | Temperature of amplifier | °C | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F63h | 00h | Temperature of encoder | °C | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F64h | 00h | Inrush resistance relay operating count | Incidences | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F65h | 00h | Dynamic brake operating count | Incidences | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F66h | 00h | Fan operating time | 30 minutes | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F67h | 00h | Fan life expectancy | 0.1% | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F68h | 00h | Capacitor life expectancy | 0.1% | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F6Ah | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F6Bh | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F6Ch | 00h | Motor power consumption | W | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4F6Dh | 00h | Amount of motor power consumption | Wh | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F6Eh | 00h | Cumulative value of motor power consumption | Wh | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |
| 4F72h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F73h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F74h | 00h | Reserved | – | – | – | U16 | – | – | – | – | – | – |
| 4F77h | 00h | Lost link error count | Incidences | 0 to 65535 | – | U16 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4F78h | 00h | Synchronization signal error count | Incidences | 0 to 65535 | – | U16 | ro | No | ALL | No | X | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4F81h | 00h | Encoder communication error count (accumulated) | Incidences | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4F82h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F83h | 00h | External scale communication error count (accumulated) | Incidences | 0 to 65535 | – | U16 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4F84h | 00h | External scale communication data error count (accumulated) | Incidences | 0 to 65535 | – | U16 | ro | TxPDO | ALL | No | X | |
| 4F85h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4F86h | 00h | Hybrid deviation | Command unit | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | *“6.6.8.7”* |
| 4F87h | 00h | External scale data (Higher) | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.1”*<br>*“6.6.6.1.2.1”*<br>*“6.6.7.1.2.1”*<br>*“6.6.8.7”* |
| 4F88h | 00h | External scale data (Lower) | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F89h | 00h | External scale status | – | 0 to 65535 | – | U16 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4F8Ah | 00h | External scale Z phase counter | – | 0 to 65535 | – | U16 | ro | No | ALL | No | X | |
| 4F8Ch | 00h | External scale single-turn data | pulse | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F91h<br>(*4) | 00h | Estimation accuracy of magnetic pole position | Degrees | 0 to 180 | – | U8 | ro | TxPDO | ALL | No | X | |
| 4F92h<br>(*4) | 00h | Execution time of estimation of magnetic pole position | ms | 0 to 65535 | – | U16 | ro | TxPDO | ALL | No | X | |
| 4F93h<br>(*4) | 00h | Maximum travel distance to plus direction when estimating magnetic pole position | pulse<br>(Feedback scale unit) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4F94h<br>(*4) | 00h | Maximum travel distance to minus direction when estimating magnetic pole position | pulse<br>(Feedback scale unit) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.3”*<br>*“6.6.6.1.2.2”*<br>*“6.6.7.1.2.2”*<br>*“6.6.8.7”* |
| 4FA4h | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | *“6.6.5.1.2.3”*<br>*“6.6.8.7”* |
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X | |
| 4FA7h | 00h | External scale position (Applied polarity) | pulse<br>(External scale) | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.4”*<br>*“6.6.6.1.2.3”*<br>*“6.6.7.1.2.3”*<br>*“6.6.8.7”* |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 4FABh | 00h | Gain switching flag | – | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | *“6.6.8.7”* |
| 4FACh | 00h | Reserved | – | – | – | I32 | – | – | – | – | – | – |
| 4FAFh | 00h | Estimated position for seamless mode change | Command unit | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | – |
| 4FB1h | 00h | Deterioration diagnosis state | – | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4FB2h | 00h | Deterioration diagnosis torque command average value | 0.1% | -2147483648 to 2147483647 | – | I32 | ro | No | ALL | No | X | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4FB3h | 00h | Deterioration diagnosis torque command standard value | 0.1% | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | *“6.6.8.7”* |
| 4FB4h | 00h | Deterioration diagnosis inertia ratio estimate value | % | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| 4FB5h | 00h | Deterioration diagnosis offset load estimate value | 0.1% | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| 4FB6h | 00h | Deterioration diagnosis dynamic friction estimate value | 0.1% | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| 4FB7h | 00h | Deterioration diagnosis viscous friction estimate value | 0.1%/ (10000 r/min) | -2147483648 to 2147483647 | — | I32 | ro | No | ALL | No | X | |
| 4FC2h (*2) | 00h | Analog input voltage | mV | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.3.6.1”*<br>*“6.6.8.7”* |
| 4FF5h | 00h | Reserved | — | — | — | I32 | — | TxPDO | — | — | — | — |
| 4FF6h | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4FF7h | — | Reserved | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 | — | U8 | ro | No | ALL | No | X | — |
| | 01h | Reserved 1 | — | — | — | I32 | — | — | — | — | — | — |
| | 02h | Reserved 2 | — | — | — | I32 | — | — | — | — | — | — |
| 4FF8h | — | Reserved | — | — | — | — | — | — | — | — | — | — |
| | 00h | Number of entries | — | 2 | — | U8 | ro | No | ALL | No | X | — |
| | 01h | Reserved 1 | — | — | — | I32 | — | — | — | — | — | — |
| | 02h | Reserved 2 | — | — | — | I32 | — | — | — | — | — | — |
| 4FFDh | 00h | Reserved | — | — | — | I32 | — | — | — | — | — | — |
| 4FFFh | 00h | Target position echo | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | *“6.6.5.1.2.2”* |

*1 Cannot be used with the standard type or multi-function type. Do not change the factory default value.

*2 Cannot be used with the standard type or multi-function type.

*3 Obj.4DA0h: “Alarm accessory information” is not compatible with PDO.

Each sub-index of Obj.4DA0h is read by SDO, so synchronism cannot be guaranteed.

*4 Cannot be used with the standard type, multi-function type, or application specialized type.

*5 Cannot be used with the standard type or multi-function type. Do not change the initial value.

## 6.2.4 Drive Profile Area (6000h to 6FFFh)

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | – | 0 to 3 | 1 | I16 | rw | No | ALL | Yes | A | *“6.6.8.2.1”* |
| 603Fh | 00h | Error code | – | 0 to 65535 | – | U16 | ro | TxPDO | ALL | No | X | *“4.2.7.3.2”*<br>TR_CS “6.1.3” |
| 6040h | 00h | Controlword | – | 0 to 65535 | 0 | U16 | rw | RxPDO | ALL | No | A | *“6.6.2”* |
| | | ● bit 0: switch on | | | | | | | | | | *“6.6.2”* |
| | | ● bit 1: enable voltage | | | | | | | | | | |
| | | ● bit 2: quick stop | | | | | | | | | | |
| | | ● bit 3: enable operation | | | | | | | | | | |
| | | ● bit 4: operation mode specific (control mode dependent bit) | | | | | | | | | | *“6.6.2”*<br>*“6.6.5.2.1.1”*<br>*“6.6.5.5.1.3”* |
| | | ● bit 5: operation mode specific (control mode dependent bit) | | | | | | | | | | *“6.6.2”*<br>*“6.6.5.2.1.1”* |
| | | ● bit 6: operation mode specific (control mode dependent bit) | | | | | | | | | | |
| | | ● bit 7: fault reset | | | | | | | | | | *“6.6.2”* |
| | | ● bit 8: halt | | | | | | | | | | |
| | | ● bit 9: operation mode specific (control mode dependent bit) | | | | | | | | | | *“6.6.2”*<br>*“6.6.5.2.1.1”* |
| 6041h | 00h | Statusword | – | 0 to 65535 | – | U16 | ro | TxPDO | ALL | No | X | *“6.6.3”* |
| | | ● bit 0: ready to switch on | | | | | | | | | | *“6.6.3”* |
| | | ● bit 1: switched on | | | | | | | | | | |
| | | ● bit 2: operation enabled | | | | | | | | | | |
| | | ● bit 3: fault | | | | | | | | | | |
| | | ● bit 4: voltage enabled | | | | | | | | | | |
| | | ● bit 5: quick stop | | | | | | | | | | |
| | | ● bit 6: switch on disabled | | | | | | | | | | |
| | | ● bit 7: warning | | | | | | | | | | |
| | | ● bit 9: remote | | | | | | | | | | |
| | | ● bit 10: operation mode specific (control mode dependent bit) | | | | | | | | | | *“6.6.3”*<br>*“6.6.5.1.2.5”*<br>*“6.6.5.5.2.1”*<br>*“6.6.6.2.2.1”*<br>*“6.6.7.2.2.1”* |
| | | ● bit 11: internal limit active | | | | | | | | | | *“6.6.3”* |
| | | ● bit 12: operation mode specific (control mode dependent bit) | | | | | | | | | | *“6.6.3”*<br>*“6.6.5.2.2.1”*<br>*“6.6.5.3.2.1”*<br>*“6.6.5.5.2.1”*<br>*“6.6.6.2.2.1”*<br>*“6.6.6.3.2.1”*<br>*“6.6.7.3.2.1”* |
| | | ● bit 13: operation mode specific (control mode dependent bit) | | | | | | | | | | *“6.6.3”*<br>*“6.6.5.1.2.5”*<br>*“6.6.5.5.2.1”* |
| 605Ah | 00h | Quick stop option code | – | -2 to 7 | 2 | I16 | rw | No | ALL | Yes | A | *“6.6.8.2.2”* |
| 605Bh | 00h | Shutdown option code | – | 0 to 1 | 1 | I16 | rw | No | ALL | Yes | A | *“6.6.8.2.3”* |
| 605Ch | 00h | Disable operation option code | – | 0 to 1 | 1 | I16 | rw | No | ALL | Yes | A | *“6.6.8.2.4”* |
| 605Dh | 00h | Halt option code | – | -1 to 3 | 1 | I16 | rw | No | ALL | Yes | A | *“6.6.8.2.5”* |
| 605Eh | 00h | Fault reaction option code | – | 0 to 2 | 2 | I16 | rw | No | ALL | Yes | A | *“6.6.8.2.6”* |
| 6060h | 00h | Modes of operation | – | -128 to 127 | 0 | I8 | rw | RxPDO | ALL | Yes | A | *“6.6.4.2”* |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6061h | 00h | Modes of operation display | – | -128 to 127 | – | I8 | ro | TxPDO | ALL | No | X | “6.6.4.3” |
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X | “6.6.5.1.2.1” |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | “6.6.5.1.2.1”<br>“6.6.6.1.2.1”<br>“6.6.7.1.2.1” |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | |
| 6065h | 00h | Following error window | Command unit | 0 to 4294967295 | 100000 | U32 | rw | RxPDO | pp<br>csp | Yes | A | “6.6.5.1.2.5” |
| 6066h | 00h | Following error time out | ms | 0 to 65535 | 0 | U16 | rw | RxPDO | pp<br>csp | Yes | A | |
| 6067h | 00h | Position window | Command unit | 0 to 4294967295 | 10 | U32 | rw | RxPDO | pp<br>ip | Yes | A | |
| 6068h | 00h | Position window time | ms | 0 to 65535 | 0 | U16 | rw | RxPDO | pp<br>ip | Yes | A | |
| 6069h | 00h | Velocity sensor actual value | – | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | “6.6.5.1.2.3”<br>“6.6.6.1.2.2”<br>“6.6.7.1.2.2” |
| 606Ah | 00h | Sensor selection code | – | -32768 to 32767 | 0 | I16 | rw | RxPDO | pv | No | X | “6.6.6.2.1.2” |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pv<br>csv | No | X | “6.6.6.1.2.2” |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | ALL | No | X | “6.6.5.1.2.3”<br>“6.6.6.1.2.2”<br>“6.6.7.1.2.2” |
| 606Dh | 00h | Velocity window | Command unit/s | 0 to 65535 | 52429 | U16 | rw | RxPDO | pv | Yes | A | “6.6.6.2.2.1” |
| 606Eh | 00h | Velocity window time | ms | 0 to 65535 | 0 | U16 | rw | RxPDO | pv | Yes | A | |
| 606Fh | 00h | Velocity threshold | Command unit/s | 0 to 65535 | 52429 | U16 | rw | RxPDO | pv | Yes | A | |
| 6070h | 00h | Velocity threshold time | ms | 0 to 65535 | 0 | U16 | rw | RxPDO | pv | Yes | A | |
| 6071h | 00h | Target torque | 0.1% | -32768 to 32767 | 0 | I16 | rw | RxPDO | tq<br>cst | Yes | A | “6.6.7.1.1.2” |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | 5000 | U16 | rw | RxPDO | ALL | Yes | A | “6.6.5.1.1.3”<br>“6.6.6.1.1.2”<br>“6.6.7.1.1.2” |
| 6073h | 00h | Max current | 0.1% | 0 to 65535 | 0 | U16 | rw | No | tq | No | X | “6.6.7.2.2.2” |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | – | I16 | ro | TxPDO | ALL | No | X | “6.6.5.1.2.4”<br>“6.6.6.1.2.3”<br>“6.6.7.1.2.3” |
| 6075h | 00h | Motor rated current | mA | 0 to 4294967295 | 0 | U32 | rw | No | ALL | No | X | “6.6.7.1.2.3” |
| 6076h | 00h | Motor rated torque | mN·m | 0 to 4294967295 | – | U32 | ro | No | ALL | No | X | “6.6.5.1.2.4”<br>“6.6.6.1.2.3”<br>“6.6.7.1.2.3” |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | – | I16 | ro | TxPDO | ALL | No | X | |
| 6078h | 00h | Current actual value | 0.1% | -32768 to 32767 | – | I16 | ro | TxPDO | ALL | No | X | “6.6.7.1.2.3” |
| 6079h | 00h | DC link circuit voltage | mV | 0 to 4294967295 | – | U32 | ro | TxPDO | ALL | No | X | |
| 607Ah | 00h | Target position | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | pp<br>csp | No | A | “6.6.5.1.1.1” |
| 607Bh | – | Position range limit | – | – | – | – | – | – | ALL | – | – | “6.6.8.4.5” |
| | 00h | Highest sub-index supported | – | 2 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | -2147483648 | I32 | rw | RxPDO | ALL | Yes | X | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 607Bh | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | 2147483647 | I32 | rw | RxPDO | ALL | Yes | X | “6.6.8.4.5” |
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | ALL | Yes | P, H | “6.6.8.4.6” |
| 607Dh | – | Software position limit | – | – | – | – | – | – | pp<br>ip<br>csp | – | – | “6.6.5.1.1.5” |
|  | 00h | Number of entries | – | 2 | – | U8 | ro | No | pp<br>ip<br>csp | No | X |  |
|  | 01h | Min position limit | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P, H |  |
|  | 02h | Max position limit | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P, H |  |
| 607Eh | 00h | Polarity | – | 0 to 255 | 0 | U8 | rw | No | ALL | Yes | P, H | – |
|  |  | ● bit 5: Torque polarity |  |  |  |  |  |  |  |  |  | “6.6.8.4.3” |
|  |  | ● bit 6: Speed polarity |  |  |  |  |  |  |  |  |  |  |
|  |  | ● bit 7: Position polarity |  |  |  |  |  |  |  |  |  |  |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | 999642454 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes | B | “6.6.5.1.1.2”<br>“6.6.6.2.1.2”<br>“6.6.7.1.1.1” |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | 7150 | U32 | rw | RxPDO | ALL | Yes | B | “6.6.5.1.1.2”<br>“6.6.5.3.5”<br>“6.6.6.1.1.1”<br>“6.6.7.1.1.1” |
| 6081h | 00h | Profile velocity | Command unit/s | 0 to 4294967295 | 0 | U32 | rw | RxPDO | pp<br>ip | Yes | A | “6.6.5.1.1.2” |
| 6082h | 00h | End velocity | Command unit/s | 0 to 4294967295 | 0 | U32 | rw | RxPDO | pp<br>ip | Yes | X |  |
| 6083h | 00h | Profile acceleration | Command unit/$s^2$ | 0 to 4294967295 | 4194304000 | U32 | rw | RxPDO | pp<br>pv<br>ip | Yes | A | “6.6.5.1.1.4”<br>“6.6.6.2.1.3” |
| 6084h | 00h | Profile deceleration | Command unit/$s^2$ | 0 to 4294967295 | 4194304000 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A | “6.6.5.1.1.4”<br>“6.6.6.2.1.3”<br>“6.6.8.2” |
| 6085h | 00h | Quick stop deceleration | Command unit/$s^2$ | 0 to 4294967295 | 4194304000 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A | “6.6.8.2” |
| 6086h | 00h | Motion profile type | – | -32768 to 32767 | 0 | I16 | rw | RxPDO | pp<br>pv<br>ip | Yes | A | “6.6.8.5” |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | 1000 | U32 | rw | RxPDO | tq<br>cst | Yes | A | “6.6.7.1.1.2”<br>“6.6.7.2.1.2”<br>“6.6.8.2” |
| 6088h | 00h | Torque profile type | – | -32768 to 32767 | 0 | I16 | rw | RxPDO | tq | Yes | A | “6.6.7.2.1.2” |
| 608Fh | – | Position encoder resolution | – | – | – | – | – | – | ALL | – | – | “6.6.8.4.2” |
|  | 00h | Highest sub-index supported | – | 2 | – | U8 | ro | No | ALL | No | X |  |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 608Fh | 01h | Encoder increments | pulse | 1 to 4294967295 | – | U32 | ro | No | ALL | No | X | *“6.6.8.4.2”* |
| | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | – | U32 | ro | No | ALL | No | X | |
| 6091h | – | Gear ratio | – | – | – | – | – | – | ALL | – | – | |
| | 00h | Number of entries | – | 2 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | 1 | U32 | rw | No | ALL | Yes | P, H | |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | 1 | U32 | rw | No | ALL | Yes | P, H | |
| 6092h | – | Feed constant | – | – | – | – | – | – | ALL | – | | |
| | 00h | Highest sub-index supported | – | 2 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Feed | Command unit | 1 to 4294967295 | 8388608 | U32 | rw | No | ALL | Yes | P, H | |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | 1 | U32 | rw | No | ALL | Yes | P, H | |
| 6098h | 00h | Homing method | – | -128 to 127 | 0 | I8 | rw | RxPDO | hm | Yes | B | *“6.6.5.5.1.4”* |
| 6099h | – | Homing speeds | – | – | – | – | – | – | hm | – | – | *“6.6.5.5.1.5”* |
| | 00h | Number of entries | – | 2 | – | U8 | ro | No | hm | No | X | |
| | 01h | Speed during search for switch | Command unit/s | 0 to 4294967295 | 873813 | U32 | rw | RxPDO | hm | Yes | A | |
| | 02h | Speed during search for zero | Command unit/s | 0 to 4294967295 | 87381 | U32 | rw | RxPDO | hm | Yes | A | |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | 4194304000 | U32 | rw | RxPDO | hm | Yes | A | *“6.6.5.5.1.6”*<br>*“6.6.8.2”* |
| 60A3h | 00h | Profile jerk use | – | 1 to 2, 255 | 1 | U8 | rw | No | pp<br>pv<br>ip | Yes | A | *“6.6.8.5”* |
| 60A4h | – | Profile jerk | – | – | – | – | – | – | pp<br>pv<br>ip | – | – | |
| | 00h | Highest sub-index supported | – | 2 | – | U8 | ro | No | pp<br>pv<br>ip | No | X | |
| | 01h | Profile jerk1 | Command unit/s$^3$ | 0 to 4294967295 | 0 | U32 | rw | No | pp<br>pv<br>ip | Yes | A | |
| | 02h | Profile jerk2 | Command unit/s$^3$ | 0 to 4294967295 | 0 | U32 | rw | No | pp<br>pv<br>ip | Yes | A | |
| 60B0h | 00h | Position offset | Command unit | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | csp | Yes | A | *“6.6.5.3.1.2”* |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A | *“6.6.5.1.1.2”*<br>*“6.6.6.1.1.1”* |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | 0 | I16 | rw | RxPDO | ALL | Yes | A | *“6.6.5.1.1.3”*<br>*“6.6.6.1.1.2”*<br>*“6.6.7.1.1.2”* |
| 60B8h | 00h | Touch probe function | – | 0 to 65535 | 0 | U16 | rw | RxPDO | ALL | No | A | – |
| | | ● bit 0: Touch Probe 1 execute, stop | | | | | | | | | | *“6.6.8.1.3”* |
| | | ● bit 1: Touch Probe 1 event mode selection | | | | | | | | | | |
| | | ● bit 2: Touch Probe 1 trigger selection (external input, Z-phase) | | | | | | | | | | |
| | | ● bit 4: Touch Probe 1 rising edge selection | | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60B8h | 00h | ● bit 5: Touch Probe 1 falling edge selection | | | | | | | | | | “6.6.8.1.3” |
| | | ● bit 8: Touch Probe 2 execute, stop | | | | | | | | | | |
| | | ● bit 9: Touch Probe 2 event mode selection (single, continuous) | | | | | | | | | | |
| | | ● bit 10: Touch Probe 2 trigger selection (external input, Z-phase) | | | | | | | | | | |
| | | ● bit 12: Touch Probe 2 rising edge selection | | | | | | | | | | |
| | | ● bit 13: Touch Probe 2 falling edge selection | | | | | | | | | | |
| | | ● bit 15: External scale monitor value 0 clear enable, disable | | | | | | | | | | |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | — | U16 | ro | TxPDO | ALL | No | X | “6.6.8.1.4” |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | “6.6.8.1.5” |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | — | I32 | ro | TxPDO | ALL | No | X | |
| 60C2h | — | Interpolation time period | — | — | — | — | — | — | ip<br>csp<br>csv<br>cst | — | — | “6.6.8.6” |
| | 00h | Highest sub-index supported | — | 2 | — | U8 | ro | No | ip<br>csp<br>csv<br>cst | No | X | |
| | 01h | Interpolation time period value | — | 0 to 255 | 1 | U8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A | |
| | 02h | Interpolation time index | — | -128 to 63 | -3 | I8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A | |
| 60C5h | 00h | Max acceleration | Command unit/s$^2$ | 0 to 4294967295 | 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A | “6.6.5.1.1.4”<br>“6.6.6.2.1.3” |
| 60C6h | 00h | Max deceleration | Command unit/s$^2$ | 0 to 4294967295 | 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A | “6.6.5.1.1.4”<br>“6.6.6.2.1.3”<br>“6.6.8.2” |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | 5000 | U16 | rw | RxPDO | ALL | Yes | A | “6.6.5.1.1.3”<br>“6.6.6.1.1.2”<br>“6.6.7.1.1.2” |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | 5000 | U16 | rw | RxPDO | ALL | Yes | A | |
| 60E3h | — | Supported homing methods | — | — | — | — | — | — | ALL | — | — | “6.6.5.5.2.2” |
| | 00h | Number of entries | — | 32 | — | U8 | ro | No | ALL | No | X | |
| | 01h | 1st supported homing method | — | -128 to 127 | — | I8 | ro | No | ALL | No | X | |
| | ⋮ | | | | | | | | | | | |
| | 20h | 32nd supported homing method | — | -128 to 127 | — | I8 | ro | No | ALL | No | X | |
| 60F2h | 00h | Position option code | — | 0 to 65535 | 0 | U16 | rw | RxPDO | pp | Yes | A | — |
| | | ● bits 1 to 0: relative option | | | | | | | | | | “6.6.5.2.1.2” |
| | | ● bits 3 to 2: change immediately option | | | | | | | | | | |
| | | ● bits 5 to 4: request-response option | | | | | | | | | | |
| | | ● bit 15: manufacturer-specific | | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Initial value | Data type | Access | PDO | Op-mode | EEPROM | Attribute | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60F4h | 00h | Following error actual value | Command unit | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X | *“6.6.5.1.2.1”* |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X | *“6.6.5.1.2.3”* |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | – | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X | *“6.6.5.1.2.1”* |
| 60FDh | 00h | Digital inputs | – | 0 to 4294967295 | – | U32 | ro | TxPDO | ALL | No | X | *“6.6.8.3.1”* |
| 60FEh | – | Digital outputs | – | – | – | – | – | – | ALL | – | – | – |
| | | ● bit 0: set brake | | | | | | | | | | *“6.6.8.3.2”* |
| | | ● bit 16: EX-OUT1 | | | | | | | | | | |
| | | ● bit 19: vel-loop torque limit | | | | | | | | | | |
| | | ● bit 20: vel-loop integral clear | | | | | | | | | | |
| | | ● bit 28: Timestamp reference time reset | | | | | | | | | | |
| | 00h | Number of entries | – | 2 | – | U8 | ro | No | ALL | No | X | |
| | 01h | Physical outputs | – | 0 to 4294967295 | 0 | U32 | rw | RxPDO | ALL | Yes | A | |
| | 02h | Bit mask | – | 0 to 4294967295 | 0 | U32 | rw | RxPDO | ALL | Yes | A | |
| 60FFh | 00h | Target velocity | Command unit/s | -2147483648 to 2147483647 | 0 | I32 | rw | RxPDO | pv<br>csv | No | A | *“6.6.6.1.1.1”* |
| 6403h | 00h | Motor catalogue number | – | – | – | VS | ro | No | ALL | No | X | *“6.6.8.7”* |
| 6502h | 00h | Supported drive modes | – | 0 to 4294967295 | – | U32 | ro | TxPDO | ALL | No | X | *“6.6.4.1”* |

## 6.3 CoE Communication Area (1000h to 1FFFh) Details

### 6.3.1 Device Information

This section describes objects related to sub device information.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000h | 00h | Device type | – | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays by device type.
  For this product, the value is fixed at 00020192h.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1001h | 00h | Error register | – | 0 to 255 | U8 | ro | No | ALL | No | X |

- The alarm type (status) generated by the product is displayed.
  When no alarm is generated, 0000h is displayed.
  No warning is displayed.

| bit | Description |
|---|---|
| 0 | (Not supported) |
| 1 | |
| 2 | |
| 3 | |
| 4 | Generation of an alarm defined by AL status code (*1) |
| 5 | (Not supported) |
| 6 | (reserved) |
| 7 | Generation of an alarm not defined by AL status code (*2) |

*1 “An alarm defined by AL status code” refers to EtherCAT communication-related errors Err80.0.0 to Err80.4.0, to Err80.6.0, to Err80.7.0, Err81.0.0 to Err81.7.0, Err85.0.0 to Err85.1.0 and Err85.3.0.

*2 “An alarm not defined by AL status code” refers to EtherCAT communication-related errors Err85.2.0, Err88.0.0 to Err88.3.0, and non-EtherCAT communication-related error.

Please see *“10 Protection Function, Warning Function, Time Stamp Function”* for a detailed description of alarms.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1008h | 00h | Manufacturer device name | – | – | VS | ro | No | ALL | No | X |

- Displays the product model in 16 characters. If it is less than 16 characters, it is filled with spaces (20h).
  Two byte NULL is appended at the end. The size of this object is 18 bytes.

(Example) Product model

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character | M | A | D | L | N | 1 | 5 | B | E | (space) | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1009h | 00h | Manufacturer hardware version | — | — | VS | ro | No | ALL | No | X |

- Displays the hardware version of the product in 16 characters. If it is less than 16 characters, it is filled with spaces (20h).
  Two byte NULL is appended at the end. The size of this object is 18 bytes.

(Example) Hardware version: 1.23

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character | V | 1 | . | 2 | 3 | (space) | | | | | | | | | | |
| Purpose | Fixed | Hardware Version | | | | | | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 100Ah | 00h | Manufacturer software version | — | — | VS | ro | No | ALL | No | X |

- Displays the software version 3 of the product in 16 characters. If it is less than 16 characters, it is filled with spaces (20h).
  Two byte NULL is appended at the end. The size of this object is 18 bytes.

(Example) Software version 3: 1.23

| byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character | V | 1 | . | 2 | 3 | (space) | | | | | | | | | | |
| Purpose | Fixed | Software Version 3 | | | | | | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018h | — | Identity object | — | — | — | — | — | — | — | — |

- Displays device information.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018h | 00h | Number of entries | — | 0 to 255 | U8 | ro | No | ALL | No | X |

- Displays the number of Obj.1018h: “Identity object” Sub-Indexes.
  The value is fixed at 04h.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018h | 01h | Vendor ID | — | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays the EtherCAT Vendor ID.
  The value is fixed at 0000066Fh.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018h | 02h | Product code | — | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays the product code.
  Values vary by Product Number. See *“2.1.2 Model Product Numbers”* .
  The value of bits 31 to 28 can be used to determine the driver series.

| | bits 31 to 28 |
|---|---|
| A7B Series | 7 |
| A6B Series | 6 |
| A5B Series | 5 or D |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018h | 03h | Revision number | – | 0 to 4294967295 | U32 | ro | No | ALL | No | A |

- Displays the product revision number.

(Example) Product revision number: 1.23

| bit | 31 to 28 | 27 to 24 | 23 to 20 | 19 to 16 | 15 to 12 | 11 to 8 | 7 to 4 | 3 to 0 |
|---|---|---|---|---|---|---|---|---|
| Value (hexadecimal) | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 3 |
| Purpose | Major revision | | | | Minor revision | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1018h | 04h | Serial number | – | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays the product serial number.

  When the sequential number part of the product serial number is “A000” to “Z999”, bits 15 to 0 of this object are set to FFFFh.

  In this case, see Obj.4D15h:00h “Drive serial number” of *“6.6.8.7 Servo Information Monitoring Object”* .

  The sequentially numbered part refers to the underlined number in the following example.

(Example) Product serial number on nameplate: “P17100001N”

| bit | 31 to 28 | 27 to 24 | 23 to 20 | 19 to 16 | 15 to 12 | 11 to 8 | 7 to 4 | 3 to 0 |
|---|---|---|---|---|---|---|---|---|
| Value (hexadecimal) | 1 | 7 | 1 | 0 | 0 | 0 | 0 | 1 |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3744h | 00h | Software version | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | Yes | X |

- Displays the software version 1 and 2 of the product.

(Example) Software version 1: 1.23, Software version 2: 4.56

| bit | 31 to 28 | 27 to 24 | 23 to 20 | 19 to 16 | 15 to 12 | 11 to 8 | 7 to 4 | 3 to 0 |
|---|---|---|---|---|---|---|---|---|
| Value (hexadecimal) | 0 | 1 | 2 | 3 | 0 | 4 | 5 | 6 |
| Purpose | (reserved) | Software version 1 | | | (reserved) | Software version 2 | | |
| | | (Major) | (Minor) | | | (Major) | (Minor) | |

## 6.3.2 Sync manager communication type (1C00h)

This section describes the objects that set the mode of operation for each SyncManager.

The setup value of the object is fixed.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C00h | — | Sync manager communication type | — | — | — | — | — | — | — | — |
| | ● Sets the operation mode of each Sync Manager. | | | | | | | | | |
| 1C00h | 00h | Number of used sync manager channels | — | 0 to 255 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of Obj.1C00h: “Sync manager communication type” Sub-Indexes. The value is fixed at 4. | | | | | | | | | |
| 1C00h | 01h | Communication type sync manager 0 | — | 0 to 4 | U8 | ro | No | ALL | No | X |
| | ● Sets the application of Sync Manager 0.<br>0: Not used<br>1: Mailbox receive (Main Device > Sub Device)<br>2: Mailbox send (Sub Device > Main Device)<br>3: RxPDO (Main Device > Sub Device)<br>4: TxPDO (Sub Device > Main Device)<br>SyncManager 0 is used for Mailbox receiving, so its value is fixed at 1. | | | | | | | | | |
| 1C00h | 02h | Communication type sync manager 1 | — | 0 to 4 | U8 | ro | No | ALL | No | X |
| | ● Sets the application of Sync Manager 1.<br>0: Not used<br>1: Mailbox receive (Main Device > Sub Device)<br>2: Mailbox send (Sub Device > Main Device)<br>3: RxPDO (Main Device > Sub Device)<br>4: TxPDO (Sub Device > Main Device)<br>SyncManager 1 is used for Mailbox sending, so the value is fixed at 2. | | | | | | | | | |
| 1C00h | 03h | Communication type sync manager 2 | — | 0 to 4 | U8 | ro | No | ALL | No | X |
| | ● Sets the application of Sync Manager 2.<br>0: Not used<br>1: Mailbox receive (Main Device > Sub Device)<br>2: Mailbox send (Sub Device > Main Device)<br>3: RxPDO (Main Device > Sub Device)<br>4: TxPDO (Sub Device > Main Device)<br>SyncManager 2 is used for Process data output (RxPDO), so the value is fixed at 3. | | | | | | | | | |
| 1C00h | 04h | Communication type sync manager 3 | — | 0 to 4 | U8 | ro | No | ALL | No | X |
| | ● Sets the application of Sync Manager 3.<br>0: Not used<br>1: Mailbox receive (Main Device > Sub Device)<br>2: Mailbox send (Sub Device > Main Device)<br>3: RxPDO (Main Device > Sub Device)<br>4: TxPDO (Sub Device > Main Device)<br>SyncManager 3 is used for Process data input (TxPDO), so the value is fixed at 4. | | | | | | | | | |

### 6.3.3 Process Data Object (PDO) Mapping

This section describes the PDO mapping object. For an overview of PDO mapping, see *“4.2.8.1 PDO Mapping Object”* and *“4.2.8.2 PDO Assign Object”* .

#### 6.3.3.1 PDO Assignment Object (1C12h to 1C13h)

The objects Obj.1C12h through Obj.1C13h are used for table allocation for PDO mapping to SyncManager.

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C12h | – | Sync manager channel 2 | – | – | – | – | – | – | – | – |
| | ● Set the entry for the PDO mapping object in Sync Manager 2.<br>Sync Manager 2 is used as Process data output (RxPDO).<br>The setting value of this object can be changed only when the ESM state is PreOP. (*1) | | | | | | | | | |
| 1C12h | 00h | Number of assigned PDOs | – | 0 to 4 | U8 | rw | No | ALL | Yes | S |
| | ● Indicates the number of assigned objects for this object. | | | | | | | | | |
| 1C12h | 01h | PDO mapping object index of assigned RxPDO 1 | – | 1600h to 1603h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C12h | 02h | PDO mapping object index of assigned RxPDO 2 | – | 1600h to 1603h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C12h | 03h | PDO mapping object index of assigned RxPDO 3 | – | 1600h to 1603h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C12h | 04h | PDO mapping object index of assigned RxPDO 4 | – | 1600h to 1603h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C13h | – | Sync manager channel 3 | – | – | – | – | – | – | – | – |
| | ● Set the entry for the PDO mapping object in Sync Manager 3.<br>Sync Manager 3 is used as Process data input (TxPDO).<br>The setting value of this object can be changed only when the ESM state is PreOP. (*1) | | | | | | | | | |
| 1C13h | 00h | Number of assigned PDOs | – | 0 to 4 | U8 | rw | No | ALL | Yes | – |
| | ● Indicates the number of assigned objects for this object. | | | | | | | | | |
| 1C13h | 01h | PDO mapping object index of assigned TxPDO 1 | – | 1A00h to 1A03h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C13h | 02h | PDO mapping object index of assigned TxPDO 2 | – | 1A00h to 1A03h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C13h | 03h | PDO mapping object index of assigned TxPDO 3 | – | 1A00h to 1A03h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |
| 1C13h | 04h | PDO mapping object index of assigned TxPDO 4 | – | 1A00h to 1A03h | U16 | rw | No | ALL | Yes | S |
| | ● Specifies the PDO mapping object to be used. | | | | | | | | | |

*1 Sub-Index 00h must first be set to 0 before 01h to 04h can be changed.

**Notes**

- Sub-Index 01h to 04h of Obj.1C12h: “Sync manager channel 2” and Obj.1C13h: “Sync manager channel 3” can be changed only when the ESM state is PreOP and Sub-Index 00h = 0. In any other status, Abort Code (06010003h) is returned. After changing the setting, set Sub-Index 00h to the number of Sub-Indexes to be used and change the ESM state to SafeOP to apply the PDO assignment object setting.

### 6.3.3.2 PDO Mapping Object (1600h to 1603h, 1A00h to 1A03h)

As a table for PDO mapping, objects Obj.1600h to Obj.1603h “Receive PDO mapping 1 to 4” can be used for RxPDO and Obj.1A00h to Obj.1A03h “Transmit PDO mapping 1 to 4” can be used for TxPDO.

Sub-Index 01h and after indicate information on the application object to be mapped.

**■ For RxPDO**

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1600h</td><td>—</td><td>Receive PDO mapping 1</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● Indicates an RxPDO object.<br>The setting value of this object can be changed only when the ESM state is PreOP. (*1)</td></tr>
<tr><td>1600h</td><td>00h</td><td>Number of entries</td><td>—</td><td>0 to 32</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Sets the number of RxPDO objects to be mapped to this object.</td></tr>
<tr><td>1600h</td><td>01h</td><td>1st receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 1st object to be mapped.
<table>
<tr><td>bit</td><td>31 to 16</td><td>15 to 8</td><td>7 to 0</td></tr>
<tr><td></td><td>Index number</td><td>SubIndex number</td><td>Bit length</td></tr>
</table></td></tr>
<tr><td>1600h</td><td>02h</td><td>2nd receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 2nd object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1600h</td><td>03h</td><td>3rd receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 3rd object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1600h</td><td>04h</td><td>4th receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 4th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1600h</td><td>05h</td><td>5th receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 5th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1600h</td><td>06h</td><td>6th receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 6th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1600h</td><td>07h</td><td>7th receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 7th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1600h</td><td>08h</td><td>8th receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 8th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td></td><td>⋮</td><td colspan="9">⋮</td></tr>
<tr><td>1600h</td><td>20h</td><td>32nd receive PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 32nd object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
</table>

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1601h</td><td>—</td><td>Receive PDO mapping 2</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● The specification of this object is the same as Obj.1600h: “Receive PDO mapping 1” .</td></tr>
<tr><td>1602h</td><td>—</td><td>Receive PDO mapping 3</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● The specification of this object is the same as Obj.1600h: “Receive PDO mapping 1” .</td></tr>
<tr><td>1603h</td><td>—</td><td>Receive PDO mapping 4</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● The specification of this object is the same as Obj.1600h: “Receive PDO mapping 1” .</td></tr>
</table>

*1 Sub-Index 00h must first be set to 0 before 01h to 20h can be changed.

**— Precautions —**

- Do not map the same object multiple times. Operation is not guaranteed when settings are made multiple times.
- Sub-Index 01h to 20h of Obj.1600h: “Receive PDO mapping 1” to Obj.1603h: “Receive PDO mapping 4” can be changed only when the ESM state is PreOP and Sub-Index 00h = 0. In any other status, Abort Code (06010003h) is returned.
- After changing the setting, set Sub-Index 00h to the number of Sub-Indexes to be used and change the ESM state to SafeOP to apply the PDO mapping object setting.

### ■ For TxPDO

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1A00h</td><td>—</td><td>Transmit PDO mapping 1</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● Indicates a TxPDO object.<br>The setting value of this object can be changed only when the ESM state is PreOP. (*1)</td></tr>
<tr><td>1A00h</td><td>00h</td><td>Number of entries</td><td>—</td><td>0 to 32</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Sets the number of TxPDO objects to be mapped to this object.</td></tr>
<tr><td>1A00h</td><td>01h</td><td>1st transmit PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 1st object to be mapped.
<table>
<tr><td>bit</td><td>31 to 16</td><td>15 to 8</td><td>7 to 0</td></tr>
<tr><td></td><td>Index number</td><td>SubIndex number</td><td>Bit length</td></tr>
</table></td></tr>
<tr><td>1A00h</td><td>02h</td><td>2nd transmit PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 2nd object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1A00h</td><td>03h</td><td>3rd transmit PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 3rd object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1A00h</td><td>04h</td><td>4th transmit PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 4th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
<tr><td>1A00h</td><td>05h</td><td>5th transmit PDO mapped</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Set the 5th object to be mapped.<br>The setup method is the same as for Sub-Index 01h.</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A00h | 06h | 6th transmit PDO mapped | — | 0 to 4294967295 | U32 | rw | No | ALL | Yes | S |
| | ● Set the 6th object to be mapped.<br>The setup method is the same as for Sub-Index 01h. | | | | | | | | | |
| 1A00h | 07h | 7th transmit PDO mapped | — | 0 to 4294967295 | U32 | rw | No | ALL | Yes | S |
| | ● Set the 7th object to be mapped.<br>The setup method is the same as for Sub-Index 01h. | | | | | | | | | |
| 1A00h | 08h | 8th transmit PDO mapped | — | 0 to 4294967295 | U32 | rw | No | ALL | Yes | S |
| | ● Set the 8th object to be mapped.<br>The setup method is the same as for Sub-Index 01h. | | | | | | | | | |
| | ⋮ | ⋮ | | | | | | | | |
| 1A00h | 20h | 32nd transmit PDO mapped | — | 0 to 4294967295 | U32 | rw | No | ALL | Yes | S |
| | ● Set the 32nd object to be mapped.<br>The setup method is the same as for Sub-Index 01h. | | | | | | | | | |
| 1A01h | — | Transmit PDO mapping 2 | — | — | — | — | — | — | — | — |
| | ● The specification of this object is the same as Obj.1A00h: “Transmit PDO mapping 1” . | | | | | | | | | |
| 1A02h | — | Transmit PDO mapping 3 | — | — | — | — | — | — | — | — |
| | ● The specification of this object is the same as Obj.1A00h: “Transmit PDO mapping 1” . | | | | | | | | | |
| 1A03h | — | Transmit PDO mapping 4 | — | — | — | — | — | — | — | — |
| | ● The specification of this object is the same as Obj.1A00h: “Transmit PDO mapping 1” . | | | | | | | | | |

*1 Sub-Index 00h must first be set to 0 before 01h to 20h can be changed.

**— Precautions —**

- Do not map the same object multiple times. Behavior is not guaranteed when settings are made multiple times.
- Sub-Index 01h to 20h of Obj.1A00h: “Transmit PDO mapping 1” to Obj.1A03h: “Transmit PDO mapping 4” can be changed when the ESM state is PreOP and Sub-Index 00h = 0. In any other status, Abort Code (06010003h) is returned.
- After changing the setting, set Sub-Index 00h to the number of Sub-Indexes to be used and change the ESM state to SafeOP to apply the PDO mapping object setting.

### 6.3.3.3 Default PDO Mapping

In this product, the default PDO mapping is defined as follows.

Note that this default PDO mapping is the value at the time of shipment of the PDO mapping object.

This content is also defined in the ESI file (.xml format).

In addition, the factory default values are set in the following format.

| bit | 31 to 16 | 15 to 8 | 7 to 0 |
|---|---|---|---|
| | Index number | SubIndex number | Bit length |

PDO mapping 1

For position control (touch probe can be used)

| | Index | Sub-Index | Size (bit) | Name | Factory default value |
|---|---|---|---|---|---|
| RxPDO (1600h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 607Ah | 00h | 32 | Target position | 607A0020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| TxPDO (1A00h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe 1 positive edge | 60BA0020h |
| | 60F4h | 00h | 32 | Following error actual value | 60F40020h |
| | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

PDO mapping 2

For position control, velocity control, torque control (touch probe can be used)

| | Index | Sub-Index | Size (bit) | Name | Factory default value |
|---|---|---|---|---|---|
| RxPDO (1601h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 6071h | 00h | 16 | Target torque | 60710010h |
| | 607Ah | 00h | 32 | Target position | 607A0020h |
| | 6080h | 00h | 32 | Max motor speed | 60800020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| | 60FFh | 00h | 32 | Target velocity | 60FF0020h |
| TxPDO (1A01h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 606Ch | 00h | 32 | Velocity actual value | 606C0020h |
| | 6077h | 00h | 16 | Torque actual value | 60770010h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe 1 positive edge | 60BA0020h |

| | Index | Sub-Index | Size (bit) | Name | Factory default value |
|---|---|---|---|---|---|
| TxPDO (1A01h) | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

PDO mapping 3

For position control and velocity control (touch probe, torque limit can be used)

| | Index | Sub-Index | Size (bit) | Name | Factory default value |
|---|---|---|---|---|---|
| RxPDO (1602h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 6072h | 00h | 16 | Max torque | 60720010h |
| | 607Ah | 00h | 32 | Target position | 607A0020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| | 60FFh | 00h | 32 | Target velocity | 60FF0020h |
| TxPDO (1A02h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 606Ch | 00h | 32 | Velocity actual value | 606C0020h |
| | 6077h | 00h | 16 | Torque actual value | 60770010h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe 1 positive edge | 60BA0020h |
| | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

PDO mapping 4

For position control, velocity control, torque control (touch probe, torque limit can be used)

| | Index | Sub-Index | Size (bit) | Name | Factory default value |
|---|---|---|---|---|---|
| RxPDO (1603h) | 6040h | 00h | 16 | Controlword | 60400010h |
| | 6060h | 00h | 8 | Modes of operation | 60600008h |
| | 6071h | 00h | 16 | Target torque | 60710010h |
| | 6072h | 00h | 16 | Max torque | 60720010h |
| | 607Ah | 00h | 32 | Target position | 607A0020h |
| | 6080h | 00h | 32 | Max motor speed | 60800020h |
| | 60B8h | 00h | 16 | Touch probe function | 60B80010h |
| | 60FFh | 00h | 32 | Target velocity | 60FF0020h |
| TxPDO (1A03h) | 603Fh | 00h | 16 | Error code | 603F0010h |
| | 6041h | 00h | 16 | Statusword | 60410010h |
| | 6061h | 00h | 8 | Modes of operation display | 60610008h |
| | 6064h | 00h | 32 | Position actual value | 60640020h |
| | 606Ch | 00h | 32 | Velocity actual value | 606C0020h |
| | 6077h | 00h | 16 | Torque actual value | 60770010h |
| | 60B9h | 00h | 16 | Touch probe status | 60B90010h |
| | 60BAh | 00h | 32 | Touch probe 1 positive edge | 60BA0020h |

| | Index | Sub-Index | Size (bit) | Name | Factory default value |
|---|---|---|---|---|---|
| TxPDO (1A03h) | 60FDh | 00h | 32 | Digital inputs | 60FD0020h |

### 6.3.3.4 PDO Mapping Setup Procedure

Using the case of adding Obj.6081h:00h “Profile velocity” to Obj.1600h: “Receive PDO mapping 1” as an example, the procedure for setting up PDO mapping is described below.

Before change

| Index | Setup value | Object contents | |
|---|---|---|---|
| Obj.1600h:01h | 60400010h | Obj.6040h:00h | Controlword |
| Obj.1600h:02h | 60600008h | Obj.6060h:00h | Modes of operation |
| Obj.1600h:03h | 607A0020h | Obj.607Ah:00h | Target position |
| Obj.1600h:04h | 60B80010h | Obj.60B8h:00h | Touch probe function |

After change

Changed location: Obj.1600h:05h added

| Index | Setup value | Object contents | |
|---|---|---|---|
| Obj.1600h:01h | 60400010h | Obj.6040h:00h | Controlword |
| Obj.1600h:02h | 60600008h | Obj.6060h:00h | Modes of operation |
| Obj.1600h:03h | 607A0020h | Obj.607Ah:00h | Target position |
| Obj.1600h:04h | 60B80010h | Obj.60B8h:00h | Touch probe function |
| Obj.1600h:05h | 60810020h | Obj.6081h:00h | Profile velocity |

■ **Setup method 1**

Setting up using an SDO message

1 Change the ESM state from Init to PreOP.

SDO messages can be sent using the Mailbox protocol.

2 Set the value of Obj.1600h:00h “Number of entries” to 0 with an SDO message.

It must be set to 0 once in order to change SubIndex 01h and after.

3 Set the value of Obj.1600h:05h “5th receive PDO mapped” to 60810020h with an SDO message.

The meaning of 60810020h is shown in the table below.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 0 | 8 | 1 | 0 | 0 | 2 | 0 | h |
| Index number | | | | SubIndex number | | Bit length | | |

4 Set the value of Obj.1600h:00h “Number of entries” to 5 with an SDO message.

This means that the Obj.1600h: “Receive PDO mapping 1” setting is used until SubIndex 05h.

5 Change the ESM state from PreOP to SafeOP.

TxPDO is enabled.

6 Change the ESM status from SafeOP to OP.

RxPDO is enabled.

**Notes**

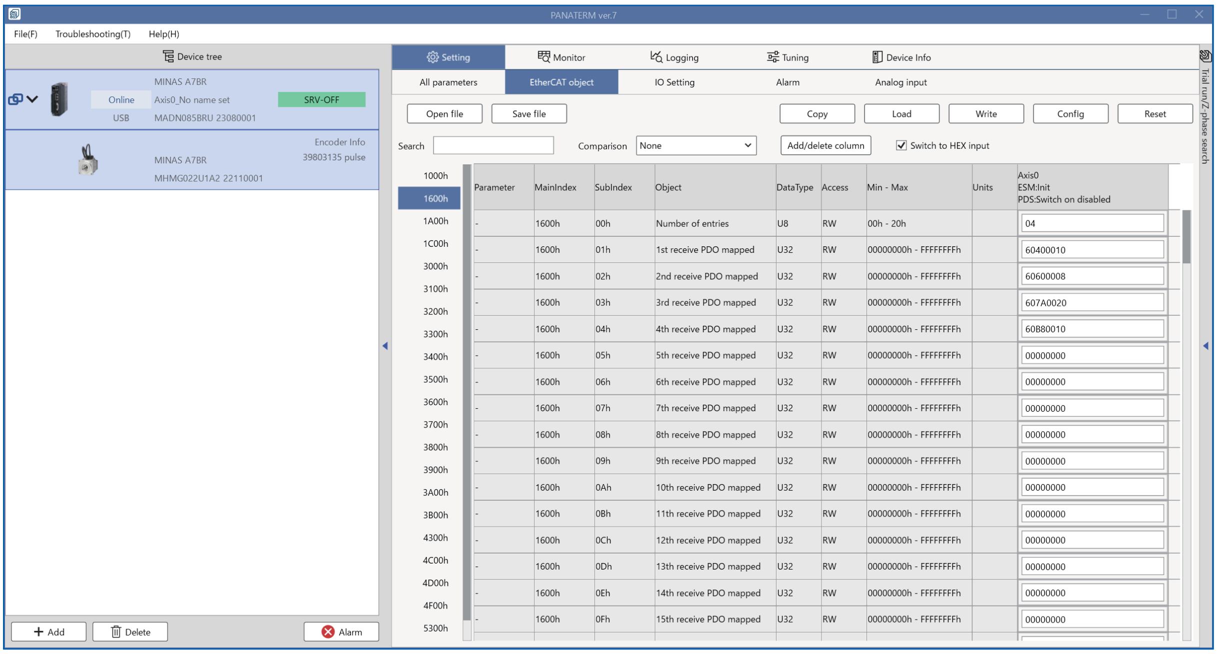
- After setting “4”, if the value of Obj.1010h:01h “Save all parameters” is set to 65766173h with an SDO message and the change is written to EEPROM, setting “2” to “4” is not necessary from the next startup. For information on how to write to EEPROM, see *“6.3.5 Store Parameters (Write Object to EEPROM) (1010h)”* .

## ■ Setup method 2

When configured using the object editor feature of Set-up Support Software (PANATERM ver.7) .

1 Change the ESM state to Init and start the object editor.

When setting up an object in the object editor, the ESM status must be Init.

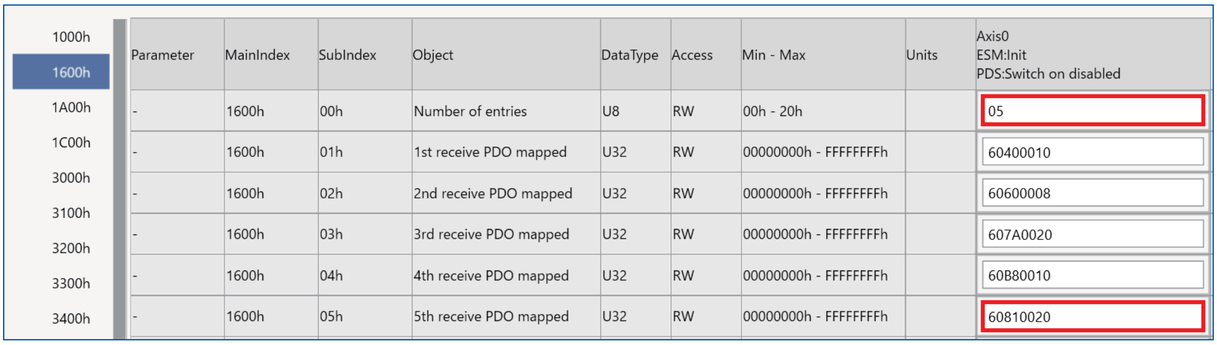


| Parameter | MainIndex | SubIndex | Object | DataType | Access | Min - Max | Units | Axis0<br>ESM:Init<br>PDS:Switch on disabled |
|---|---|---|---|---|---|---|---|---|
| - | 1600h | 00h | Number of entries | U8 | RW | 00h - 20h | | 04 |
| - | 1600h | 01h | 1st receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60400010 |
| - | 1600h | 02h | 2nd receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60600008 |
| - | 1600h | 03h | 3rd receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 607A0020 |
| - | 1600h | 04h | 4th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60B80010 |
| - | 1600h | 05h | 5th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 06h | 6th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 07h | 7th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 08h | 8th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 09h | 9th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 0Ah | 10th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 0Bh | 11th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 0Ch | 12th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 0Dh | 13th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 0Eh | 14th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |
| - | 1600h | 0Fh | 15th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 00000000 |

2 Input 5 for the value of Obj.1600h:00h “Number of entries” .

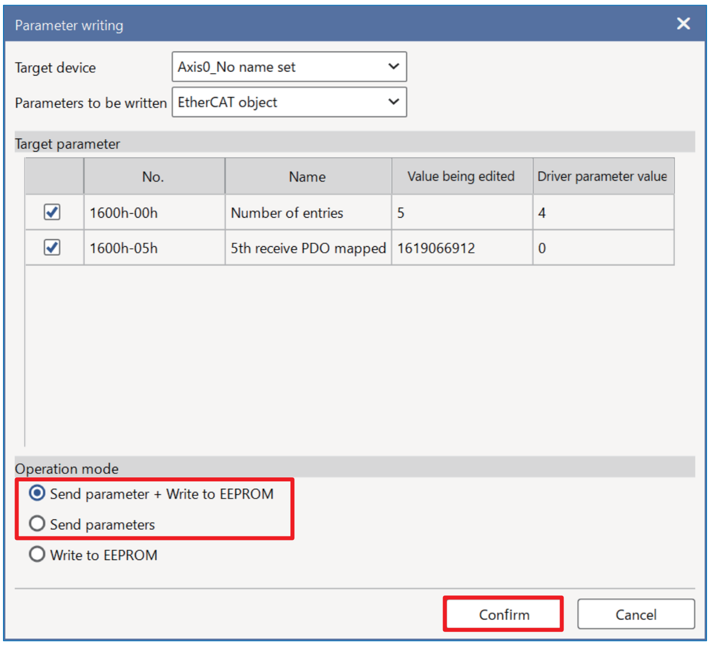
3 Input 60810020h for the value of Obj.1600h:05h “5th receive PDO mapped” .

The order of Steps 2 and 3 can be interchanged.



| Parameter | MainIndex | SubIndex | Object | DataType | Access | Min - Max | Units | Axis0<br>ESM:Init<br>PDS:Switch on disabled |
|---|---|---|---|---|---|---|---|---|
| - | 1600h | 00h | Number of entries | U8 | RW | 00h - 20h | | 05 |
| - | 1600h | 01h | 1st receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60400010 |
| - | 1600h | 02h | 2nd receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60600008 |
| - | 1600h | 03h | 3rd receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 607A0020 |
| - | 1600h | 04h | 4th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60B80010 |
| - | 1600h | 05h | 5th receive PDO mapped | U32 | RW | 00000000h - FFFFFFFFh | | 60810020 |

4 Click “Write” in the upper right corner of the screen, select “Send Parameter + Write EEPROM” or “Send Parameter” on the displayed parameter writing screen, and click “Confirm”.



Target device: Axis0_No name set

Parameters to be written: EtherCAT object

Target parameter

| | No. | Name | Value being edited | Driver parameter value |
|---|---|---|---|---|
| ☑ | 1600h-00h | Number of entries | 5 | 4 |
| ☑ | 1600h-05h | 5th receive PDO mapped | 1619066912 | 0 |

Operation mode

● Send parameter + Write to EEPROM

○ Send parameters

○ Write to EEPROM

5 Change the ESM state from Init to PreOP.

6 Change the ESM state from PreOP to SafeOP.

TxPDO is enabled.

7 Change the ESM status from SafeOP to OP.

RxPDO is enabled.

## 6.3.4 Sync Manager 2/3 Synchronization (1C32h, 1C33h)

This section describes the settings for SyncManager 2 and SyncManager 3.

### 6.3.4.1 Sync Manager 2 Synchronization (1C32h)

SyncManager 2 is configured with Obj.1C32h: “Sync manager 2 synchronization” .

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1C32h</td><td>—</td><td>Sync manager 2 synchronization</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="11">● Configure the settings for Sync manager 2.</td></tr>
<tr><td>1C32h</td><td>00h</td><td>Number of sub-objects</td><td>—</td><td>0 to 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the number of Obj.1C32h: “Sync manager 2 synchronization” Sub-Indexes.<br>The value is fixed at 20h.</td></tr>
<tr><td>1C32h</td><td>01h</td><td>Sync mode</td><td>—</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td colspan="11">● Sets the Sync Manager 2 synchronous mode.<br>00h: FreeRun (not synchronized)<br>01h: SM2 (synchronized with SM 2 Event)<br>02h: DC SYNC0 (synchronized with Sync0 Event)<br>03h: Not supported (cannot be set)<br>● The setup value of this object is automatically set at the change from PreOP to SafeOP according to the combination with the setting of ESC register 0981h “Activation” .
<table>
<tr><td>ESC register 0981h setting status</td><td>Obj.1C32h:01h setup value</td><td></td><td>Value of Obj.1C32h:01h is changed during change from PreOP to SafeOP</td></tr>
<tr><td rowspan="3">DC Enable ON</td><td>00h: FreeRun</td><td rowspan="6">to</td><td>02h: DC SYNC0</td></tr>
<tr><td>01h: SM2</td><td>02h: DC SYNC0</td></tr>
<tr><td>02h: DC SYNC0</td><td>02h: DC SYNC0</td></tr>
<tr><td rowspan="3">DC Enable OFF</td><td>00h: FreeRun</td><td>00h: FreeRun</td></tr>
<tr><td>01h: SM2</td><td>01h: SM2</td></tr>
<tr><td>02h: DC SYNC0</td><td>00h: FreeRun</td></tr>
</table></td></tr>
<tr><td>1C32h</td><td>02h</td><td>Cycle time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td colspan="11">● Sets the Sync Manager cycle.
<table>
<tr><th>Sync mode (Obj.1C32h:01h)</th><th>Function</th></tr>
<tr><td>00h (FreeRun)</td><td>Sets the interval between events by the local timer.<br>0 can also be set.<br>0 is set when transitioning to Safe-OP.</td></tr>
<tr><td>01h (Synchronous with SM2)</td><td>Sets the minimum time interval for SM2 events.</td></tr>
<tr><td>02h (DC SYNC0)</td><td>Sync0 Cycle Time (ESC register: 09A0h) is set.</td></tr>
</table>
● Set one of 62500 (62.5 μs), 125000 (125 μs), 250000 (250 μs), 500000 (500 μs), 1000000 (1 ms), 2000000 (2 ms), 4000000 (4 ms), 8000000 (8 ms) or 10000000 (10 ms). Any other value will cause Err81.0.0 “Synchronization cycle error protection” to occur.</td></tr>
<tr><td>1C32h</td><td>03h</td><td>Shift time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
</table>

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1C32h</td><td>04h</td><td>Sync modes supported</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">
<ul><li>The supported synchronization types are set.</li></ul>
<table>
<tr><td>bit 0</td><td>FreeRun mode support</td><td>0: Not supported<br>1: FreeRun mode support</td><td>1 is set for this product.</td></tr>
<tr><td>bit 1</td><td>SM Synchronous mode support</td><td>0: Not supported<br>1: SM2 event synchronization support</td><td>1 is set for this product.</td></tr>
<tr><td>bits 4 to 2</td><td>DC synchronous mode support</td><td>000b: Not supported<br>001b: DC sync0 event support</td><td>001b is set for this product.</td></tr>
<tr><td>bits 6 to 5</td><td>Output shift support</td><td>00b: Not supported<br>01b : Shift support for local timer</td><td>00b is set for this product.</td></tr>
<tr><td>bits 15 to 7</td><td>Reserved</td><td>—</td><td>—</td></tr>
</table>
</td></tr>
<tr><td>1C32h</td><td>05h</td><td>Minimum cycle time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>The minimum value of the communication cycle that can be set.<br>In this product, it is 62500. (*1)</li></ul></td></tr>
<tr><td>1C32h</td><td>06h</td><td>Calc and copy time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Time from SM2 event and SYNC0 event to ESC reading completion.<br>If the signal is scattered, this time may be longer.<br>In this product, it is 15000. (*1)</li></ul></td></tr>
<tr><td>1C32h</td><td>08h</td><td>Command</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Not supported</li></ul></td></tr>
<tr><td>1C32h</td><td>09h</td><td>Delay time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>The hardware delay time between the completion of the ESC read and its availability to the sub device application.<br>0 for this servo driver. (*1)</li></ul></td></tr>
<tr><td>1C32h</td><td>0Ah</td><td>Sync0 cycle time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>For DC SYNC0 (Obj.1C32h:01h = 02h), the value of ESC register 09A0h is set.<br>For other than DC SYNC0, 0 is set.</li></ul></td></tr>
<tr><td>1C32h</td><td>0Bh</td><td>SM-event missed</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Not supported</li></ul></td></tr>
<tr><td>1C32h</td><td>0Ch</td><td>Cycle time too small</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Not supported</li></ul></td></tr>
<tr><td>1C32h</td><td>0Dh</td><td>Shift time too short</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Not supported</li></ul></td></tr>
<tr><td>1C32h</td><td>0Eh</td><td>RxPDO toggle failed</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Not supported</li></ul></td></tr>
<tr><td>1C32h</td><td>20h</td><td>Sync error</td><td>—</td><td>0 to 1</td><td>BOOL</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11"><ul><li>Not supported</li></ul></td></tr>
</table>

*1 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

### 6.3.4.2 Sync Manager 3 Synchronization (1C33h)

SyncManager 3 is configured with Obj.1C33h: “Sync manager 3 synchronization” .

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1C33h</td><td>—</td><td>Sync manager 3 synchronization</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● Configure the settings for Sync manager 3.</td></tr>
<tr><td>1C33h</td><td>00h</td><td>Number of sub-objects</td><td>—</td><td>0 to 255</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the number of Obj.1C33h: “Sync manager 3 synchronization” Sub-Indexes.<br>The value is fixed at 20h.</td></tr>
<tr><td>1C33h</td><td>01h</td><td>Sync mode</td><td>—</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Sets the Sync Manager 3 synchronous mode. Set to the same mode as Sync Manager 2.<br>00h: FreeRun (not synchronized)<br>01h: Not supported (cannot be set)<br>02h: DC SYNC0 (synchronized with Sync0 Event)<br>03h: Not supported (cannot be set)<br>22h: SM2 (synchronized with SM2 Event)<br>● The setup value of this object is automatically set at the change from PreOP to SafeOP according to the combination (in the table below) with the setting of ESC register 0981h “Activation” .
<table>
<tr><th>ESC register 0981h setting status</th><th>Obj.1C33h:01h setup value</th><th></th><th>Value of Obj.1C33h:01h is changed during change from PreOP to SafeOP</th></tr>
<tr><td rowspan="3">DC Enable ON</td><td>00h: FreeRun</td><td rowspan="6">to</td><td>02h: DC SYNC0</td></tr>
<tr><td>22h: SM2</td><td>02h: DC SYNC0</td></tr>
<tr><td>02h: DC SYNC0</td><td>02h: DC SYNC0</td></tr>
<tr><td rowspan="3">DC Enable OFF</td><td>00h: FreeRun</td><td>00h: FreeRun</td></tr>
<tr><td>22h: SM2</td><td>22h: SM2</td></tr>
<tr><td>02h: DC SYNC0</td><td>00h: FreeRun</td></tr>
</table>
</td></tr>
<tr><td>1C33h</td><td>02h</td><td>Cycle time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● The Sync Manager cycle is set.<br>The value is set to the same value as Obj.1C32h:02h “Cycle time” .</td></tr>
<tr><td>1C33h</td><td>03h</td><td>Shift time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>S</td></tr>
<tr><td></td><td colspan="10">● Sets the time from the Sync0 and SM2 events until the sub device CPU writes the RxPDO value to ESC.<br>Set the value in 62500 increments that are smaller than the Cycle time.<br>Normally, set to 0.</td></tr>
</table>

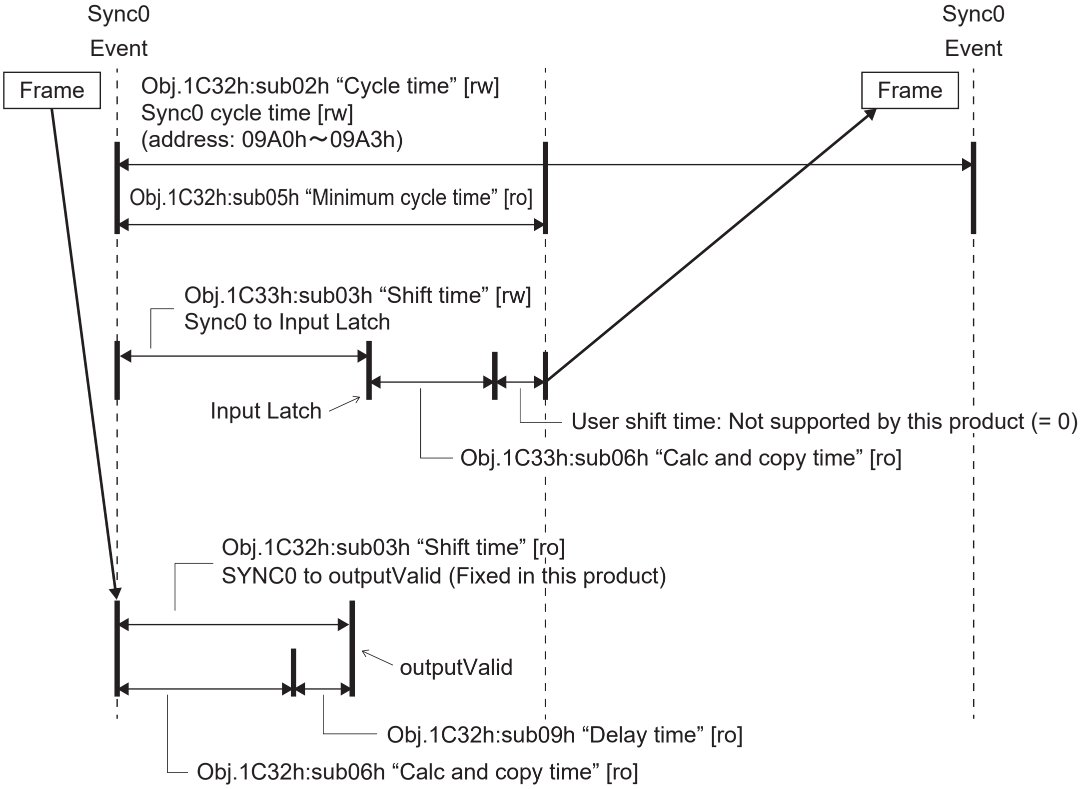
<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>1C33h</td><td>04h</td><td>Sync modes supported</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● The supported synchronization types are set.
<table>
<tr><td>bit 0</td><td>FreeRun mode support</td><td>0: Not supported<br>1: FreeRun mode support</td><td>1 is set for this product.</td></tr>
<tr><td>bit 1</td><td>SM Synchronous mode support</td><td>0: Not supported<br>1: SM2 event synchronization support</td><td>1 is set for this product.</td></tr>
<tr><td>bits 4 to 2</td><td>DC synchronous mode support</td><td>000b: Not supported<br>001b: DC sync0 event support</td><td>001b is set for this product.</td></tr>
<tr><td>bits 6 to 5</td><td>Output Shift Support Input Shift Support</td><td>00b: Not supported<br>01b : Shift support for local timer</td><td>01b is set for this product.</td></tr>
<tr><td>bits 15 to 7</td><td>Reserved</td><td>—</td><td>—</td></tr>
</table></td></tr>
<tr><td>1C33h</td><td>05h</td><td>Minimum cycle time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● The minimum value of the communication cycle that can be set.<br>The same value as that of Obj.1C32h-05h</td></tr>
<tr><td>1C33h</td><td>06h</td><td>Calc and copy time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Time from SM2 event and SYNC0 event to completion of writing to the ESC register.<br>In this product, it is 42000. (*1)</td></tr>
<tr><td>1C33h</td><td>08h</td><td>Command</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
<tr><td>1C33h</td><td>09h</td><td>Delay time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● This is the hardware delay time before data is available to be written to the ESC from the sub device application.<br>In this servo driver, it is set to 0.</td></tr>
<tr><td>1C33h</td><td>0Ah</td><td>Sync0 cycle time</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● The same value as that of Obj.1C32h-0Ah</td></tr>
<tr><td>1C33h</td><td>0Bh</td><td>SM-event missed</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
<tr><td>1C33h</td><td>0Ch</td><td>Cycle time too small</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
<tr><td>1C33h</td><td>0Dh</td><td>Shift time too short</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
<tr><td>1C33h</td><td>0Eh</td><td>RxPDO toggle failed</td><td>—</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
<tr><td>1C33h</td><td>20h</td><td>Sync error</td><td>—</td><td>0 to 1</td><td>BOOL</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Not supported</td></tr>
</table>

*1 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

#### 6.3.4.3 DC (SYNC0 Event Synchronization)

| Synchronization method | Characteristics |
|---|---|
| The time information of another sub device is synchronized on the basis of the time on the first axis | ● High precision<br>● Requires compensation processing on the main device side |

The DC synchronous mode specifications for this product are as follows.



Sync manager 2/3 synchronization settings in DC synchronous mode

—: N/A

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 00h | Number of sub-objects | — | 20h | U8 | ro | No | ALL | No | X |
|  | 01h | Sync mode | — | 02h: “DC SYNC0”<br>(synchronized with Sync0 Event) | U16 | rw | No | ALL | Yes | S |
|  | 02h | Cycle time | ns | 62.5 μs: 62500<br>125 μs: 125000<br>250 μs: 250000<br>500 μs: 500000<br>1 ms: 1000000<br>2 ms: 2000000<br>4 ms: 4000000<br>8 ms: 8000000<br>10 ms: 10000000 | U32 | rw | No | ALL | Yes | S |
|  | 03h | Shift time | ns | Not supported | U32 | ro | No | ALL | No | X |

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 04h | Sync modes supported | — | bit 4 to 2 “DC synchronous mode support”<br>001b: DC SYNC0 event support | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | 62500 (*1) | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | 15000 (*1) | U32 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | 0 (*1) | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | ESC Register 09A0h value | U32 | ro | No | ALL | No | X |
| | 0Bh | SM-event missed | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Ch | Cycle time too small | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | Not supported | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | Not supported | BOOL | ro | No | ALL | No | X |

*1 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

—: N/A

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C33h | 00h | Number of sub-objects | — | Same setting as Obj.1C32h:00h “Number of sub-objects” | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | — | 02H: DC SYNC0 “synchronized with Sync0 Event” | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | Same setting as Obj.1C32h:02h “Cycle time” | U32 | ro | No | ALL | No | X |
| | 03h | Shift time | ns | 0 ns to 3875000 ns<br>(Set timing to write TxPDO value from sub device CPU to ESC in 62500 ns increments) | U32 | rw | No | ALL | No | S |
| | 04h | Sync modes supported | — | 27h (*1) | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | Same setting as Obj.1C32h:05h “Minimum cycle time” | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | 42000 (*2) | U32 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | Same setting as Obj.1C32h:09h “Delay time” | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | Same setting as Obj.1C32h:0Ah “Sync0 cycle time” | U32 | ro | No | ALL | No | X |
| | 0Bh | SM-event missed | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Ch | Cycle time too small | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | Not supported | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | Not supported | BOOL | ro | No | ALL | No | X |

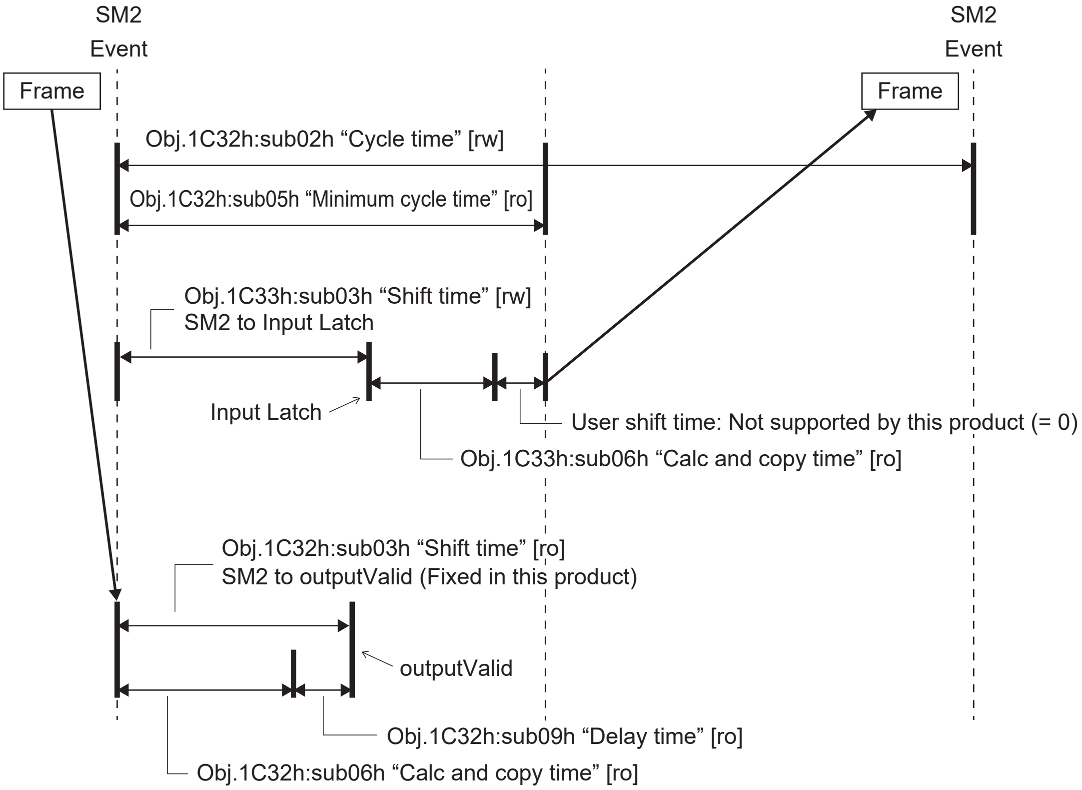
*1 For setup details, see *“6.3.4 Sync Manager 2/3 Synchronization (1C32h, 1C33h)”* .

*2 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

### 6.3.4.4 SM2 (SM2 Event Synchronization)

| Synchronization method | Characteristics |
|---|---|
| Synchronized with RxPDO reception timing | ● Precision is poor without transmission delay correction<br>● Transmission timing must be kept constant at the controller side (dedicated hardware, etc.) |

The SM2 mode specifications for this product are as follows.



Sync manager 2/3 synchronization settings in SM2 Event synchronous mode

—: N/A

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 00h | Number of sub-objects | — | 20h (fixed) | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | — | 01h: SM2 (synchronized with SM2 Event) | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | 62.5 μs: 62500<br>125 μs: 125000<br>250 μs: 250000<br>500 μs: 500000<br>1 ms: 1000000<br>2 ms: 2000000<br>4 ms: 4000000<br>8 ms: 8000000<br>10 ms: 10000000 | U32 | rw | No | ALL | Yes | S |
| | 03h | Shift time | ns | Not supported | U32 | ro | No | ALL | No | X |

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 04h | Sync modes supported | — | bit 1 “SM Synchronous mode support”<br>1: SM2 event synchronization support | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | 62500 (*1) | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | 15000 (*1) | U32 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | 0 (*1) | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | 0 | U32 | ro | No | ALL | No | X |
| | 0Bh | SM-event missed | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Ch | Cycle time too small | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | Not supported | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | Not supported | BOOL | ro | No | ALL | No | X |

*1 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

—: N/A

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C33h | 00h | Number of sub-objects | — | Same setting as Obj.1C32h:00h “Number of sub-objects” | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | — | 22h: SM2 (synchronized with SM2 Event) | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | Same setting as Obj.1C32h:02h “Cycle time” | U32 | ro | No | ALL | No | X |
| | 03h | Shift time | ns | 0 ns to 3875000 ns<br>(Set timing to write TxPDO value from sub device CPU to ESC in 62500 ns increments) | U32 | rw | No | ALL | No | S |
| | 04h | Sync modes supported | — | 27h (*1) | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | Same setting as Obj.1C32h:05h “Minimum cycle time” | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | 42000 (*2) | U32 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | Same setting as Obj.1C32h:09h “Delay time” | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | Same setting as Obj.1C32h:0Ah “Sync0 cycle time” | U32 | ro | No | ALL | No | X |
| | 0Bh | SM-event missed | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Ch | Cycle time too small | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | Not supported | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | Not supported | BOOL | ro | No | ALL | No | X |

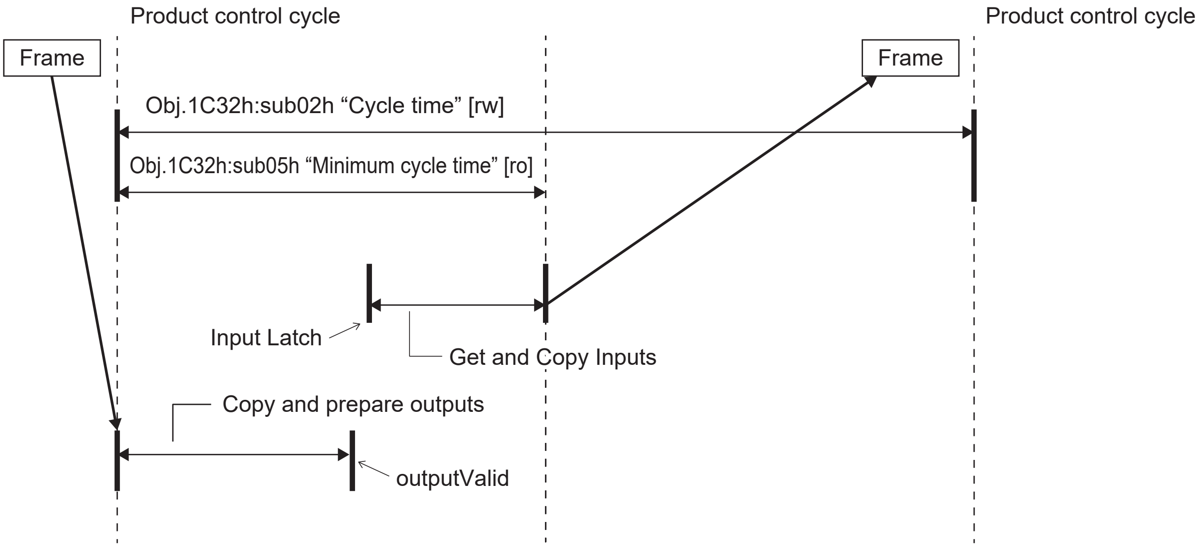
*1 For setup details, see *“6.3.4 Sync Manager 2/3 Synchronization (1C32h, 1C33h)”* .

*2 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

### 6.3.4.5 FreeRun (Asynchronous)

| Synchronization method | Characteristics |
|---|---|
| Asynchronous | • Processing is simple<br>• Lacks real-time properties |

The FreeRun mode specifications for this product are as follows.



Sync manager 2/3 synchronization settings in FreeRun mode

–: N/A

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 00h | Number of sub-objects | – | 20h (fixed) | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | – | 00h: FreeRun (not synchronized) | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | 62.5 μs: 62500<br>125 μs: 125000<br>250 μs: 250000<br>500 μs: 500000<br>1 ms: 1000000<br>2 ms: 2000000<br>4 ms: 4000000<br>8 ms: 8000000<br>10 ms: 10000000 | U32 | rw | No | ALL | Yes | S |
| | 03h | Shift time | ns | Not supported | U32 | ro | No | ALL | No | X |
| | 04h | Sync modes supported | – | bit 0 “FreeRun mode support”<br>1: FreeRun mode support | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | 62500 (*1) | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | Not supported | U32 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | Not supported | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | 0 | U32 | ro | No | ALL | No | X |
| | 0Bh | SM-event missed | – | Not supported | U16 | ro | No | ALL | No | X |
| | 0Ch | Cycle time too small | – | Not supported | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | – | Not supported | U16 | ro | No | ALL | No | X |

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C32h | 20h | Sync error | — | Not supported | BOOL | ro | No | ALL | No | X |

*1 Setting values are for reference only and are not guaranteed. This setup value may change due to the amount of data to be written to the ESC or errors in the timing of transmission from the host device.

—: N/A

| Index | Sub-Index | Name | Units | Value | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1C33h | 00h | Number of sub-objects | — | Same setting as Obj.1C32h:00h “Number of sub-objects” | U8 | ro | No | ALL | No | X |
| | 01h | Sync mode | — | 00h: FreeRun (not synchronized) | U16 | rw | No | ALL | Yes | S |
| | 02h | Cycle time | ns | Same setting as Obj.1C32h:02h “Cycle time” | U32 | ro | No | ALL | No | X |
| | 03h | Shift time | ns | Not supported | U32 | rw | No | ALL | No | S |
| | 04h | Sync modes supported | — | 27h (*1) | U16 | ro | No | ALL | No | X |
| | 05h | Minimum cycle time | ns | Same setting as Obj.1C32h:05h “Minimum cycle time” | U32 | ro | No | ALL | No | X |
| | 06h | Calc and copy time | ns | Same setting as Obj.1C32h:06h “Calc and copy time” | U32 | ro | No | ALL | No | X |
| | 09h | Delay time | ns | Same setting as Obj.1C32h:09h “Delay time” | U32 | ro | No | ALL | No | X |
| | 0Ah | Sync0 cycle time | ns | Same setting as Obj.1C32h:0Ah “Sync0 cycle time” | U32 | ro | No | ALL | No | X |
| | 0Bh | SM-event missed | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Ch | Cycle time too small | — | Not supported | U16 | ro | No | ALL | No | X |
| | 0Dh | Shift time too short | — | Not supported | U16 | ro | No | ALL | No | X |
| | 20h | Sync error | — | Not supported | BOOL | ro | No | ALL | No | X |

*1 For setup details, see *“6.3.4 Sync Manager 2/3 Synchronization (1C32h, 1C33h)”* .

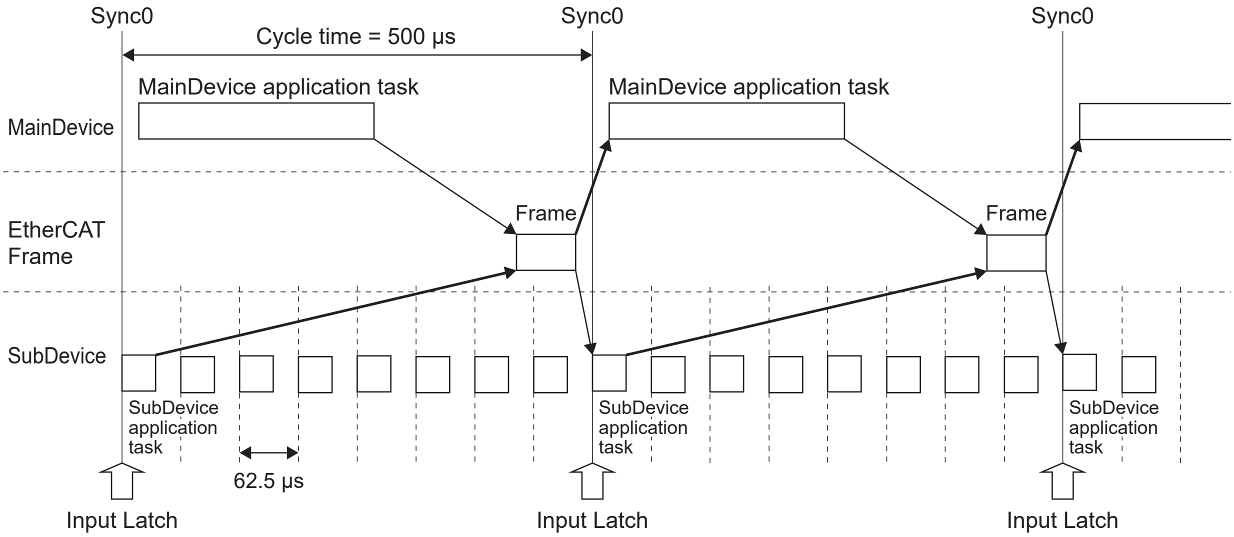
### 6.3.4.6 Input Shift Time

This product supports Input shift time to provide the latest sub device information to the main device.

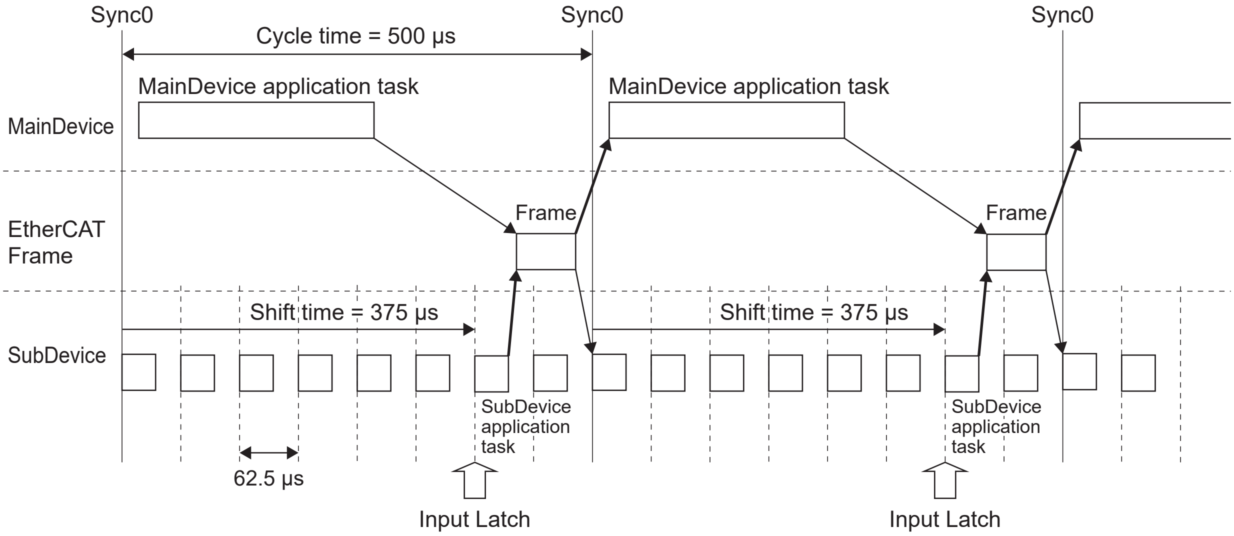
By setting Obj.1C33h:03h “Shift time” , the Input Latch timing can be adjusted in 62.5 µs increments and set to a value as close to the TxPDO frame transmission as possible.

In particular, this is effective when the communication cycle time is long, allowing more recent TxPDO values to be written.

**DC cycle time = 500 µs, Input shift time = 0 µs**



**DC cycle time = 500 µs, Input shift time = 375 µs**



### 6.3.5 Store Parameters (Write Object to EEPROM) (1010h)

This section describes objects for writing object data to EEPROM.

Using Obj.1010h:01h “Save all parameters” , send 65766173h (“save”) with EtherCAT communication data to the sub device, which writes the object data with differences on EEPROM and RAM to EEPROM at once (backup).

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 1010h | — | Store parameters | — | — | — | — | — | — | — | — |
| | | ● Writes (backs up) object data to EEPROM. | | | | | | | | |
| 1010h | 00h | Number of entries | — | 0 to 255 | U8 | ro | No | ALL | No | X |
| | | ● Indicates the number of sub-indexes for this object.<br>The value is fixed at 1. | | | | | | | | |
| 1010h | 01h | Save all parameters | — | 0 to 4294967295 | U32 | rw | No | ALL | No | A |
| | | ● By writing 65766173h (“save”) on the EtherCAT communication data, all the object tables to be backed up are backed up to EEPROM together.<br>When the process is completed, the value is 00000001h regardless of success or failure.<br>After the control power is turned on, the value is 00000001h. | | | | | | | | |

When Err11.0.0 “Control power supply undervoltage protection” occurs, EEPROM cannot be accessed and objects cannot be stored in EEPROM.

Writing time to EEPROM may take up to 10 seconds (For example, when changing all objects.).

Do not shut off the control power supply while writing to the EEPROM.

In the servo parameter area (objects in the 3000h area), writing to the EEPROM is enabled for objects with attributes C and R by resetting the control power supply.

There is a limit to the number of EEPROM writes.

No other SDO commands are accepted while writing to EEPROM.

An abort message is returned in the following cases.

For write access to Obj.1010h:00h “Number of entries”

Write data to Obj.1010h:01h “Save all parameters” is a value other than 65766173h (“save”)

For other Abort messages, see *“4.2.7.3.1 Abort Messages”* .

### 6.3.6 Diagnosis history (Error (Alarm) History Readout Function) (10F3h)

This section describes the object for reading the alarm history.

Obj.10F3h: “Diagnosis history” can be used to read max. 30 errors (alarms) from the history.

The error (alarm) history is stored in Obj.10F3h:06h “Diagnosis message 1” starting with the error (alarm) that occurred max. 30 errors before, and max. 30 errors are stored in sequence in the order they occurred up to Obj.10F3h:23h “Diagnosis message 30” .

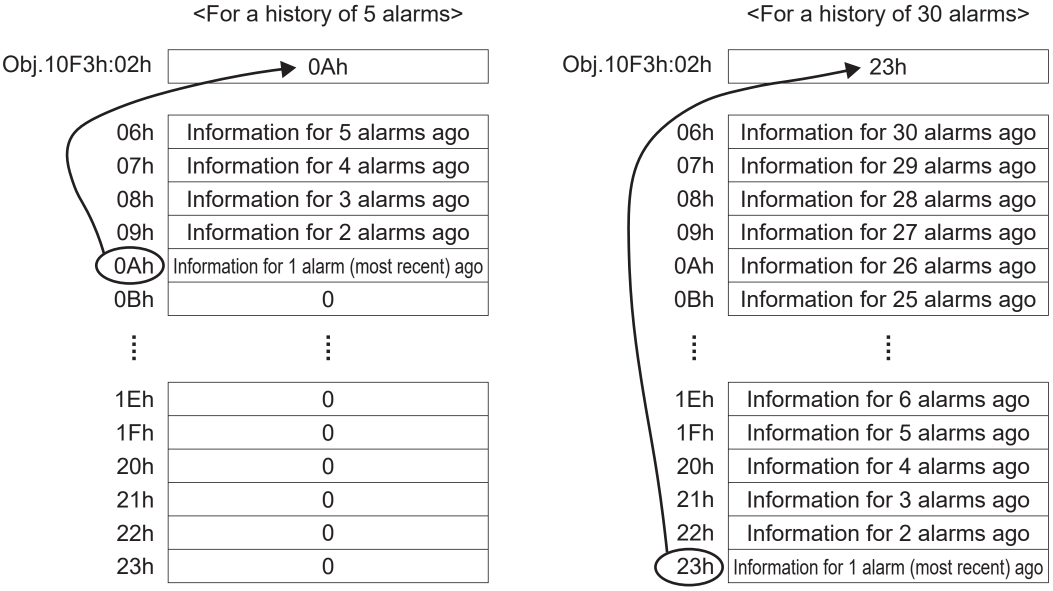
The sub-index number where the most recent error (alarm) history is stored can be checked from Obj.10F3h:02h “Newest message” .

Obj.10F3h: “Diagnosis history” does not support PDO. Each sub-index of Obj.10F3h: “Diagnosis history” is read by SDO so synchronism cannot be guaranteed.

The error (alarm) history displayed in Obj.10F3h: “Diagnosis history” is set by reading the information backed up in the EEPROM of this product when the control power is turned on.

The error (alarm) history displayed in Obj.10F3h: “Diagnosis history” remains only alarms that occurred in the product. Warnings are not displayed or stored.

In addition, there are alarms that are not displayed and stored in Obj.10F3h: “Diagnosis history” .



<For a history of 5 alarms>

| | |
|---|---|
| Obj.10F3h:02h | 0Ah |
| 06h | Information for 5 alarms ago |
| 07h | Information for 4 alarms ago |
| 08h | Information for 3 alarms ago |
| 09h | Information for 2 alarms ago |
| 0Ah | Information for 1 alarm (most recent) ago |
| 0Bh | 0 |
| ⋮ | ⋮ |
| 1Eh | 0 |
| 1Fh | 0 |
| 20h | 0 |
| 21h | 0 |
| 22h | 0 |
| 23h | 0 |

<For a history of 30 alarms>

| | |
|---|---|
| Obj.10F3h:02h | 23h |
| 06h | Information for 30 alarms ago |
| 07h | Information for 29 alarms ago |
| 08h | Information for 28 alarms ago |
| 09h | Information for 27 alarms ago |
| 0Ah | Information for 26 alarms ago |
| 0Bh | Information for 25 alarms ago |
| ⋮ | ⋮ |
| 1Eh | Information for 6 alarms ago |
| 1Fh | Information for 5 alarms ago |
| 20h | Information for 4 alarms ago |
| 21h | Information for 3 alarms ago |
| 22h | Information for 2 alarms ago |
| 23h | Information for 1 alarm (most recent) ago |

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 10F3h | — | Diagnosis history | — | — | — | — | — | — | — | — |
| | | ● Settings are executed to enable or disable error history readouts and emergency messages. | | | | | | | | |
| 10F3h | 00h | Number of entries | — | 0 to 255 | U8 | ro | No | ALL | No | X |
| | | ● Indicates the number of sub-indexes for this object.<br>The value is fixed at 23h. | | | | | | | | |
| 10F3h | 01h | Maximum messages | — | 0 to 255 | U8 | ro | No | ALL | No | X |
| | | ● Displays the number of error messages that can be stored by the product.<br>The value is fixed at 1Eh (30 times). | | | | | | | | |
| 10F3h | 02h | Newest message | — | 0 to 255 | U8 | ro | No | ALL | No | — |
| | | ● Displays the sub-index where the latest error message is stored.<br>If there is no alarm history, such as immediately after clearing the alarm history, 0 is displayed. | | | | | | | | |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>10F3h</td><td>03h</td><td>Newest acknowledged message</td><td>—</td><td>0 to 255</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">
● On read: Always 0<br>
● On write:<br>
Write setting value 00h and all Diagnosis Messages will be cleared.<br>
Write a setting other than 00h and then SDO Abort will output (Code 06090030h).
</td></tr>
<tr><td>10F3h</td><td>04h</td><td>New messages available</td><td>—</td><td>0 to 1</td><td>BOOL</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">
● Not supported by this product.<br>
The value is fixed at 0.
</td></tr>
<tr><td>10F3h</td><td>05h</td><td>Flags</td><td>—</td><td>0 to 65535</td><td>U16</td><td>See below</td><td>No</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">
<table>
<tr><td>bit 0</td><td>rw</td><td>Emergency message execution permission<br>● 0: Emergency messages disabled<br>● 1: An emergency message is issued for each new error detected<br>(May not be left in a diagnosis message, depending on the error)<br>For more information about Emergency messages, see *“4.2.7.3.2 Emergency Messages”* .</td></tr>
<tr><td>bit 1</td><td>r</td><td>Not supported: 1 fixed</td></tr>
<tr><td>bit 2</td><td>r</td><td>Not supported: 1 fixed</td></tr>
<tr><td>bit 3</td><td>r</td><td>Not supported: 0 fixed</td></tr>
<tr><td>bit 4</td><td>r</td><td>Not supported: 0 fixed</td></tr>
<tr><td>bit 5</td><td>r</td><td>Diagnosis message clearing information<br>● 0: There is error history information<br>● 1: There is no error history information, or error history information clearing<br>(When Obj.10F3h:03h “Newest acknowledged message” = 0 is written) Complete<br>(Stored until the next error (alarm) occurs)</td></tr>
<tr><td>bits 15 to 6</td><td>—</td><td>Reserved</td></tr>
</table>
</td></tr>
<tr><td>10F3h</td><td>06h</td><td>Diagnosis message 1</td><td>—</td><td>—</td><td>OS</td><td>ro</td><td>No</td><td>ALL</td><td>No (*1)</td><td>X</td></tr>
<tr><td colspan="11">
Displays error history.
<table>
<tr><td>Example</td><td>00</td><td>E8</td><td>10</td><td>FF</td><td>02</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td><td>00</td></tr>
<tr><td rowspan="2">Purpose</td><td>(L)</td><td>(H)</td><td>(L)</td><td>(H)</td><td>(L)</td><td>(H)</td><td>(L)</td><td>(H)</td><td>(L)</td><td colspan="6"></td><td>(H)</td></tr>
<tr><td colspan="2">(Fixed value)</td><td colspan="2">Error Code</td><td colspan="2">(Fixed value)</td><td colspan="2">Text ID</td><td colspan="8">(Fixed value)</td></tr>
<tr><td></td><td colspan="4">Diag code</td><td colspan="2">Flags</td><td colspan="2">Text ID</td><td colspan="8">Timestamp</td></tr>
</table>

**Diag code**<br>
Diagnostic code identifying the message<br>
Error code returns the value set in Obj.603Fh:00h “Error code” .<br>
**Flags**<br>
The value is fixed at 0002h.<br>
**Text ID**<br>
Returns the Text ID defined for the error message (Error code).<br>
The main alarm number is set in the upper 8 bits and the sub alarm number in the lower 8 bits.<br>
**Timestamp**<br>
The time when the error occurs. The value is fixed at 0000000000000000h because it is not yet supported.
</td></tr>
<tr><td></td><td>⋮</td><td colspan="9">⋮</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 10F3h | 23h | Diagnosis message 30 | – | – | OS | ro | No | ALL | No<br>(*1) | X |
| | ● Displays error history.<br>The contents are the same as for sub-index 06h. | | | | | | | | | |

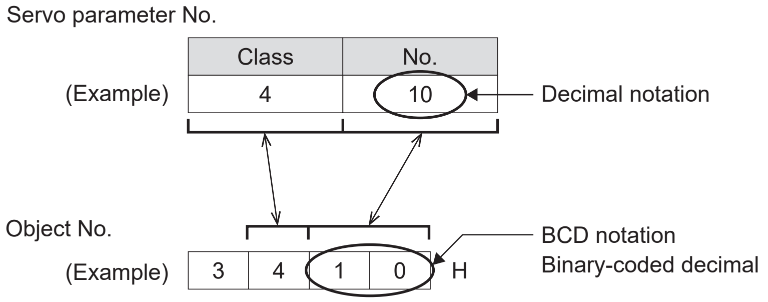
*1 It is not backed up as an object, but is transferred from separately backed up alarm information.

## 6.4 Servo Parameter Area (3000h to 3FFFh) Details

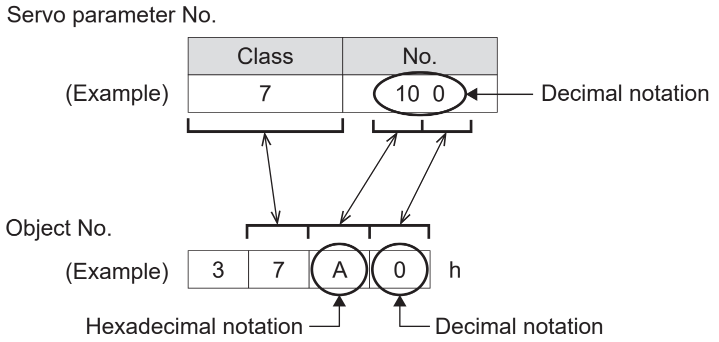
Servo parameters are assigned to objects in the 3000h area.

The servo parameter number and object number are supported as follows.

### When the servo parameter number is less than 100



### When the servo parameter number is 100 or more



## 6.5 User-specific Area (4000h to 4FFFh) Details

The user-specific area is an object in the manufacturer-defined area and is used in this product for objects that improve the performance and convenience of the function.

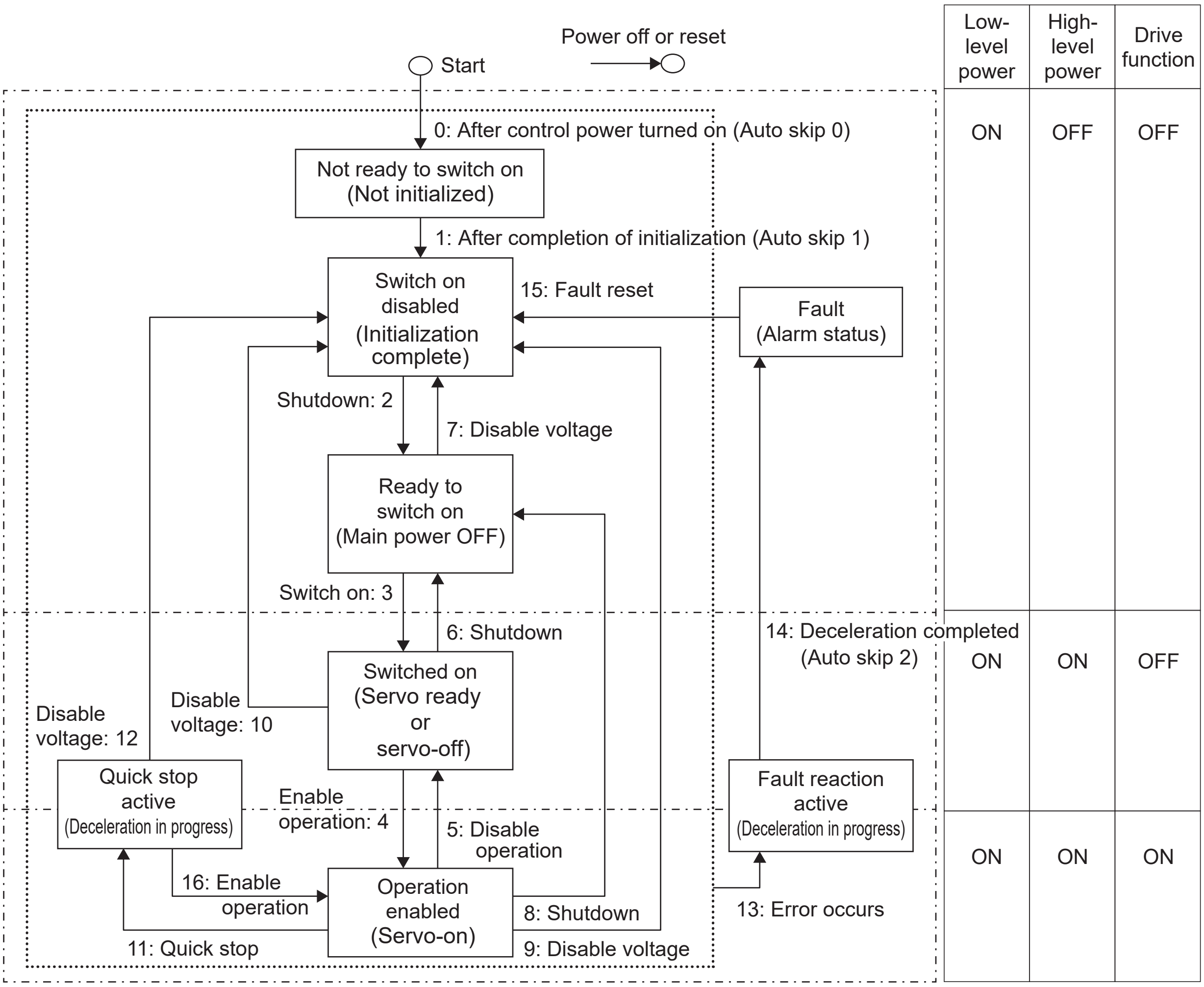
For more information on the objects in the user-specific area, check the description of the functions that use the relevant object. For the section describing the functions, see *"6.2.3 User-specific Area (4000h to 4FFFh)"* .

## 6.6 Drive Profile Area (6000h to 6FFFh) Details

### 6.6.1 Power Drive Systems (PDS) Status

The PDS status indicates the state of the power supply from the product's power control, either by user command or by error detection, etc.

The status transitions of PDS are defined in the figure below.



* Low-level power: Control power High-level power: Main power Drive function: Servo-on

High-level power (main power) must be ON for this product to be servo ready.

When High-level power (main power) is OFF, the servo is not servo ready and cannot change to the switched on state.

During the safe torque-off state, the Switch on disabled state is set regardless of the High-level power (main power) status.

After changing to Operation enabled (servo-on), wait at least 100 ms before sending an operation command.

### PDS state transition events (transition conditions) and transition actions

For PDS transitions, make sure to send the next transition command after confirming that the state has transitioned with Obj.6041h:00h “Statusword” .

| PDS transitions | | Event (s) | Action (s) |
|---|---|---|---|
| 0 | Auto skip 0 | ● Automatic transition after control power is turned on or after application reset. | ● Self-diagnosis and initialization process of drive functions are performed. |
| 1 | Auto skip 1 | ● Automatic transition after initialization is completed. | ● Communication is established. |
| 2 | Shutdown | ● Shutdown command received while not in safe torque off state. | ● None in particular. |
| 3 | Switch on | ● A switch on command was received while High-level power was ON. | ● None in particular. |
| 4 | Enable operation | ● Enable operation command received. | ● Enables the drive function.<br>In addition, all previous set-point data is cleared. |
| 5 | Disable operation | ● Disable operation command received. | ● Disables the drive function. |
| 6 | Shutdown | ● Shutdown command was received while High-level power was ON.<br>● High-level power OFF status detected. | ● None in particular. |
| 7 | Disable voltage | ● When the Disable voltage command is received.<br>● Quick stop command received.<br>● Transitioned to Init when ESM state is Pre-OP, SafeOP, or OP.<br>● Safe torque-off status is now in effect. | ● None in particular. |
| 8 | Shutdown | ● Shutdown command was received while High-level power was ON. | ● Disables the drive function. |
| 9 | Disable voltage | ● Disable voltage command received.<br>● Detected High-level power OFF with Abort connection option code value of 2.<br>● Safe torque-off status is now in effect. | ● Disables the drive function. |
| 10 | Disable voltage | ● Disable voltage command received.<br>● Quick stop command received.<br>● Transitioned to Init when ESM state is Pre-OP, SafeOP, or OP.<br>● Safe torque-off status is now in effect. | ● None in particular. |
| 11 | Quick stop | ● Quick stop command received.<br>● Detected High-level power OFF with Abort connection option code value of 3. | ● Starts execution of the Quick stop function. |
| 12 | Disable voltage | ● Quick stop option code is set to 1, 2, or 3 and the Quick stop operation is completed.<br>● Disable voltage command was received when the Quick stop option code was 5, 6, or 7 and the Quick stop operation was completed.<br>● High-level power OFF status detected.<br>● Safe torque-off status is now in effect. | ● Disables the drive function. |
| 13 | Error occurs | ● Error detected.<br>● Detected High-level power OFF with Abort connection option code value of 1.<br>● Trigger to start retracting operation was detected. | ● Performs the configured Fault reaction function.<br>● Performs retracting operation function |

| PDS transitions | | Event (s) | Action (s) |
|---|---|---|---|
| 14 | Auto skip 2 | ● Automatic transition occurred after completion of error detection and deceleration processing.<br>● Automatic transition occurred after completion or interruption of retracting operation. | ● Disables the drive function. |
| 15 | Fault reset | ● Fault reset command was received after the error cause was removed. | ● If the fault cause is not present, perform a reset of the fault status. |
| 16 | Enable operation | ● When the Quick stop option code setting value is 5, 6, or 7, the Enable operation command was received. | ● Enables the drive function. |

## 6.6.2 Controlword (6040h)

Commands that control the sub device (this product), such as PDS state transitions, are set in Obj.6040h:00h "Controlword" .

**— Precautions —**

- Whenever this object is used, it must be used with PDO and the PDO watchdog must be enabled.
  SDO cannot determine if communication is interrupted, and the motor may remain energized, which is unsafe.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands to the product, such as PDS state transitions.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | | | | | (2) | (3) | (4) | (2) | | | (5) | (6) | (7) | (8) |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on

- Bit 7, 3 to 0 (fault reset, enable operation, quick stop, enable voltage, switch on)

Represents a PDS command. The table below shows the combination of commands and the supported bits.

— : Undefined

| Command | bits of the controlword | | | | | PDS transitions |
|---|---|---|---|---|---|---|
| | bit 7 | bit 3 | bit 2 | bit 1 | bit 0 | |
| | fault reset | enable operation | quick stop | enable voltage | switch on | |
| Shutdown | 0 | — | 1 | 1 | 0 | 2, 6, 8 |
| Switch on | 0 | 0 | 1 | 1 | 1 | 3 |
| Switch on<br>+ Enable operation | 0 | 1 | 1 | 1 | 1 | 3 + 4<br>(*1) |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4, 16 |
| Disable voltage | 0 | — | — | 0 | — | 7, 9, 10, 12 |
| Quick stop | 0 | — | 0<br>(*2) | 1 | — | 7, 10, 11 |
| Disable operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Fault reset | ↑ | — | — | — | — | 15 |

*1 After executing the Switch on command, execute the Enable operation command.

*2 The bit logic of the quick stop command is enabled by 0.
Note that this is the opposite behavior of bit logic for other commands.

- Bit 8 (halt)

  When 1, the motor decelerates to a temporary stop according to the Obj.605Dh:00h “Halt option code” setting.

  After the temporary stop, the operation is resumed when the value is set back to 0. However, in hm control mode, the operation is interrupted by 1 and does not resume when set back to 0.

- Bit 9, 6 to 4 (operation mode specific (control mode dependent bit))

  Control mode (Op-mode) specific operation mode specific bit operations are shown in the table below (For details, see the Related Objects section for each control mode.).

—: Unused (set bits to 0)

| Op-mode | bit 9 | bit 6 | bit 5 | bit 4 |
|---|---|---|---|---|
| pp | change on set-point | absolute / relative | change set immediately | new set-point |
| csp | — | — | — | — |
| ip | — | — | — | enable interpolation |
| hm | — | — | — | start homing |
| pv | — | — | — | — |
| csv | — | — | — | — |
| tq | — | — | — | — |
| cst | — | — | — | — |

### 6.6.3 Statusword (6041h)

The status of the sub device (this product) is checked with Obj.6041h:00h “Statusword” .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | (2) | | (3) | (2) | (4) | (1) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on

- bit 6, 5, 3 to 0

  “switch on disabled, quick stop, fault, operation enabled, switched on, ready to switch on”

  You can check the status of PDS with these bits. The states and supported bits are indicated in the table.

| Statusword | PDS state | |
|---|---|---|
| xxxx xxxx x0xx 0000 b | Not ready to switch on | Initialization incomplete state |
| xxxx xxxx x1xx 0000 b | Switch on disabled | Initialization complete state |
| xxxx xxxx x01x 0001 b | Ready to switch on | Main circuit power supply off state |
| xxxx xxxx x01x 0011 b | Switched on | Servo off, servo ready |
| xxxx xxxx x01x 0111 b | Operation enabled | Servo-on |
| xxxx xxxx x00x 0111 b | Quick stop active | Quick stop |
| xxxx xxxx x0xx 1111 b | Fault reaction active | Error (alarm) recognition |
| xxxx xxxx x0xx 1000 b | Fault | Error (alarm) state |

- bit 4 “voltage enabled”

  A value of 1 indicates that the main circuit power supply voltage is applied to the PDS.

- bit 5 “quick stop”

  A value of 0 indicates that the PDS has accepted the quick stop request.

  The bit logic of quick stop is activated by 0.

  Note that this is the opposite behavior of bit logic for other commands.

- bit 7 “warning”

  A value of 1 indicates that a warning has occurred. When there is a warning, there is no change in PDS state and motor operation continues.

- bit 8 “reserved”

This bit is unused (fixed at 0).

- bit 9 “remote”

  0 (local) indicates that Obj.6040h:00h “Controlword” cannot be processed.

  1 (remote) indicates that Obj.6040h:00h “Controlword” can be processed.

  1 when the ESM state changes to PreOP or higher.

  In the 0 state, Obj.6041h:00h “Statusword” should not refer to anything other than this bit.

  This bit is set to 0 regardless of the ESM status during operation with Set-up Support Software (PANATERM ver.7) (trial run, frequency characteristics analysis function (FFT function), One Minute TUNING, and Z-phase search).

- Bit 13, 12, 10 “operation mode specific (control mode dependent bit)”

  Control mode specific oms bit operations are shown in the table below.

  (For details, see the “Related Objects” section for each control mode.)

—: Unused (Undefined)

| Op-mode | bit 13 | bit 12 | bit 10 |
|---|---|---|---|
| pp | following error | set-point acknowledge | target reached |
| csp | following error | drive follows command value | — |
| ip | — | ip mode active | target reached |
| hm | homing error | homing attained | target reached |
| pv | max slippage error<br>(Not supported) | speed | target reached |
| csv | — | drive follows command value | — |
| tq | — | — | target reached |
| cst | — | drive follows command value | — |

- bit 11 “internal limit active”

  Obj.6041h:00h “Statusword” :bit 11 “internal limit active” is set to 1 when the cause could be an internal limitation.

  The conditions under which Obj.6041h:00h “Statusword” :bit 11 “internal limit active” is 1 are shown in the table below.

| Control mode | | Internal limitation causes | Servo on/off state |
|---|---|---|---|
| Position control | pp, csp | Emergency stop (*1) | On only |
| | | Torque limit | On only (*2) |
| | | Over-travel inhibit inputs (POT, NOT) | On/off |
| | | Software limit | On/off |
| | hm | Emergency stop (*1) | On only |
| | | Torque limit | On only (*2) |
| Velocity control | pv, csv | Emergency stop (*1) | On only |
| | | Torque limit | On only (*2) |
| | | Over-travel inhibit inputs (POT, NOT) | On/off |
| Torque control | tq, cst | Emergency stop (*1) | On only |
| | | Torque limit (*3) | On only (*2) |
| | | Over-travel inhibit inputs (POT, NOT) | On/off |
| | | Velocity limit | On only |

*1 This excludes cases where the torque limit condition is not reached even during an emergency stop.

*2 When the torque limit value is 0, bit 11 “internal limit active” is set to 1 even in the servo-off state.

The torque limit indicates the minimum value among the following.

- t-value (Obj.6071h:00h “Target torque” +Obj.60B2h:00h “Torque offset” ) (only during torque control (tq, cst))
- Obj.6072h:00h “Max torque”
- Obj.3013h:00h “1st torque limit”
- Obj.3522h:00h “2nd torque limit” (only when no torque control and (Obj.3521h:00h “Selection of torque limit” = 2 or 4))
- Obj.60E0h:00h “Positive torque limit value” ,Obj.60E1h:00h “Negative torque limit value” (only if Obj.3521h:00h “Selection of torque limit” = 5)

*3 The torque limit judgment condition can be switched during torque control with the Obj.3703h:00h “Output setup during torque limit” setting.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3703h | 00h | Output setup during torque limit | — | 0 to 1 | I16 | rw | No | cst<br>tq | Yes | A |
| ● Set up judgment condition of output while torque is limited by torque control.<br>0: Torque limit judgment condition includes “torque command value (Obj.6071h:00h “Target torque” +Obj.60B2h:00h “Torque offset” )”<br>1: Torque limit judgment condition does not include “torque command value (Obj.6071h:00h “Target torque” +Obj.60B2h:00h “Torque offset” )” | | | | | | | | | | |

- bit 15, 14 “reserved”

  This bit is unused (fixed at 0).

## 6.6.4 Control Mode Confirmation and Setup

### 6.6.4.1 Supported Drive Modes (6502h)

The control modes (modes of operation) supported by this product can be confirmed with Obj.6502h:00h “Supported drive modes” .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6502h | 00h | Supported drive modes | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays supported control modes (Modes of operation).
  A value of 1 indicates the mode is supported.

—: N/A

| bit | Modes of operation | Abbreviation | Supported |
|---|---|---|---|
| 0 | Profile position mode<br>(Profile position control mode) | pp | Yes |
| 1 | Velocity mode<br>(Velocity control mode) | vl | No |
| 2 | Profile velocity mode<br>(Profile velocity control mode) | pv | Yes |
| 3 | Torque profile mode<br>(Profile torque control mode) | tq | Yes |
| 4 | reserved | — | No |
| 5 | Homing mode<br>(Homing position control mode) | hm | Yes |
| 6 | Interpolated position mode<br>(Interpolated position control mode) | ip | No |
| 7 | Cyclic synchronous position mode<br>(Cyclic position control mode) | csp | Yes |
| 8 | Cyclic synchronous velocity mode<br>(Cyclic velocity control mode) | csv | Yes |
| 9 | Cyclic synchronous torque mode<br>(Cyclic torque control mode) | cst | Yes |
| 10 | reserved | — | No |
| ⋮ | | | |
| 15 | | | |
| 16 | manufacturer-specific | — | No |
| ⋮ | | | |
| 31 | | | |

### 6.6.4.2 Modes of Operation (6060h)

The control mode is set with Obj.6060h:00h “Modes of operation” .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6060h | 00h | Modes of operation | — | -128 to 127 | I8 | rw | RxPDO | ALL | Yes | A |

- Sets the control mode of this product.
  The default value is 0.
  Setting of unsupported control modes is prohibited.

—: N/A

| Value | Modes of operation | Abbreviation | Supported |
|---|---|---|---|
| -128 to -1 | Reserved | — | — |
| 0 | No mode change/no mode assigned<br>(mode not changed/mode not set) | — | Yes |
| 1 | Profile position mode<br>(Profile position control mode) | pp | Yes |
| 2 | Velocity mode<br>(Velocity control mode) | vl | No |
| 3 | Profile velocity mode<br>(Profile velocity control mode) | pv | Yes |
| 4 | Torque profile mode<br>(Profile torque control mode) | tq | Yes |
| 6 | Homing mode<br>(Homing position control mode) | hm | Yes |
| 7 | Interpolated position mode<br>(Interpolated position control mode) | ip | No |
| 8 | Cyclic synchronous position mode<br>(Cyclic position control mode) | csp | Yes |
| 9 | Cyclic synchronous velocity mode<br>(Cyclic velocity control mode) | csv | Yes |
| 10 | Cyclic synchronous torque mode<br>(Cyclic torque control mode) | cst | Yes |
| 11 to 127 | Reserved | — | — |

Obj.6060h:00h “Modes of operation” is default = (No mode change/no mode assigned), so be sure to set the control mode value to use after the control power is turned on.

If the PDS state is changed to Operation enabled when the setting value of Obj.6060h:00h “Modes of operation” is 0 and the setting value of Obj.6061h:00h “Modes of operation display” is 0, Err88.1.0 “Control mode setting error protection” occurs.

If a control mode not supported by the SDO is set, an Abort message is returned as out of range.

There are some precautions to be taken when switching control modes. For details, see *“6.6.4.4 Precautions for Switching the Control Mode”* .

### 6.6.4.3 Modes of Operation Display (6061h)

The internal control mode of the product can be checked with Obj.6061h:00h “Modes of operation display” .

After setting Obj.6060h:00h “Modes of operation” , monitor this object to confirm that it is operating as configured.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6061h | 00h | Modes of operation display | — | -128 to 127 | I8 | ro | TxPDO | ALL | No | X |

- Displays the current control mode.
  The definition is the same as Obj.6060h:00h “Modes of operation” .

—: N/A

| Value | Modes of operation | Abbreviation | Supported |
|---|---|---|---|
| -128 to -1 | Reserved | — | — |
| 0 | No mode change/no mode assigned<br>(mode not changed/mode not set) | — | Yes |
| 1 | Profile position mode<br>(Profile position control mode) | pp | Yes |
| 2 | Velocity mode<br>(Velocity control mode) | vl | No |
| 3 | Profile velocity mode<br>(Profile velocity control mode) | pv | Yes |
| 4 | Torque profile mode<br>(Profile torque control mode) | tq | Yes |
| 6 | Homing mode<br>(Homing position control mode) | hm | Yes |
| 7 | Interpolated position mode<br>(Interpolated position control mode) | ip | No |
| 8 | Cyclic synchronous position mode<br>(Cyclic position control mode) | csp | Yes |
| 9 | Cyclic synchronous velocity mode<br>(Cyclic velocity control mode) | csv | Yes |
| 10 | Cyclic synchronous torque mode<br>(Cyclic torque control mode) | cst | Yes |
| 11 to 127 | Reserved | — | — |

### 6.6.4.4 Precautions for Switching the Control Mode

- The control mode can be switched by changing the value of Obj.6060h:00h “Modes of operation” .
- Check the current control mode of the product with Obj.6061h:00h “Modes of operation display” .
- When switching control modes, synchronize and update the RxPDO objects associated with Obj.6060h:00h “Modes of operation” and the control mode.
- Object values not supported by the modified control mode are undefined.
- It takes approximately 2 ms from the time of control mode change to the completion of switching. In the meantime, the values of the TxPDO objects associated with Obj.6061h:00h “Modes of operation display” and the control mode are undefined.
- This product does not support control mode switching during operation.

  Perform control mode switching while the motor is stopped. Operation cannot be guaranteed if the control mode is switched during motor operation (including homing operation and mid-deceleration to stop). The mode may not switch immediately, or Err27.4.0 “Position command error protection” may occur, for example.
- If the PDS state is changed to “Operation enabled” with Obj.6060h:00h “Modes of operation” = 0 and Obj.6061h:00h “Modes of operation display” = 0, Err88.1.0 “Control mode setting error protection” will occur.
- If Obj.6060h:00h “Modes of operation” is once set to a value other than 0 and then Obj.6060h:00h “Modes of operation” = 0, the previous control mode is retained.
- If a control mode not supported by Obj.6060h:00h “Modes of operation” is set, Err88.1.0 “Control mode setting error protection” will occur.
- In full-closed control, only position control-related operation is supported. Therefore, when using full-closed control, if Obj.6060h:00h “Modes of operation” is set to 3 (pv), 4 (tq), 9 (csv), or 10 (cst), Err88.1.0 “Control mode setting error protection” will occur.
- When two-degree-of-freedom control mode (synchronization type) is enabled, Err88.1.0 “Control mode setting error protection” occurs when Obj.6060h:00h “Modes of operation” is set to 3 (pv) or 9 (csv) because velocity control is not supported.

## 6.6.5 Position Control Function (pp, csp, ip, hm)

The following types of position control mode are available:

- Profile position control (pp)
- Cyclic position control (csp)
- Interpolated position control (ip)
- Homing position control (hm)

This section describes the objects used in the above position control mode functions. For a position control system overview, see *"7.3 Position Control"* .

### 6.6.5.1 Position Control Common Functions

This section describes the objects used in each position control mode function.

For control block diagrams, see below.

- *"Control block diagram: Position control (when two-degree-of-freedom control mode is enabled) "*
- *"Control block diagram: Position control (when two-degree-of-freedom control mode is disabled)"*
- *"Control block diagram: Full-closed control (when two-degree-of-freedom control mode is enabled)"*
- *"Control block diagram: Full-closed control (when two-degree-of-freedom control mode is disabled)"*

The control block diagram is described using servo parameter numbers. For the relationship between servo parameter numbers and object numbers, see *"6.4 Servo Parameter Area (3000h to 3FFFh) Details"* .

#### 6.6.5.1.1 Objects Commonly Related to Position Control (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 607Ah | 00h | Target position | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>csp | No | A |
| 607Dh | — | Software position limit | — | — | — | — | — | pp<br>csp<br>ip | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | pp<br>csp<br>ip | No | X |
| | 01h | Min position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>csp<br>ip | Yes | P<br>H |
| | 02h | Max position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>csp<br>ip | Yes | P<br>H |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>hm | Yes | B |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 6081h | 00h | Profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6082h | 00h | End velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | X |
| 6083h | 00h | Profile acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6084h | 00h | Profile deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60C5h | 00h | Max acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>hm | Yes | A |
| 60C6h | 00h | Max deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>hm | Yes | A |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60F2h | 00h | Position option code | — | 0 to 65535 | U16 | rw | RxPDO | pp | Yes | A |

There are other objects associated with each position control mode. Also, Obj.6040h:00h “Controlword” has different functions in each position control mode. For a description of the functions of the associated objects and Obj.6040h:00h “Controlword” for each position control mode, see below.

- *“6.6.5.2 Profile Position Control Mode (pp mode)”*
  1. *“6.6.5.2.1 Objects Related to pp Control Mode (Command/Setting-related)”*
  2. *“6.6.5.2.2 Objects Related to pv Control Mode (Monitoring-related)”*
- *“6.6.5.3 Cyclic Position Control Mode (csp mode)”*
  1. *“6.6.5.3.1 Objects Related to csp Control Mode (Command/Setting-related)”*
  2. *“6.6.5.3.2 Objects Related to csp Control Mode (Monitoring-related)”*
- *“6.6.5.5 Homing Position Control Mode (hm mode)”*
  1. *“6.6.5.5.1 Objects Related to hm Control Mode (Command/Setting-related)”*
  2. *“6.6.5.5.2 Objects Related to hm Control Mode (Monitoring-related)”*

### 6.6.5.1.1.1 Position-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Ah | 00h | Target position | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>csp | No | A |
| | ● Sets the target position. | | | | | | | | | |

### 6.6.5.1.1.2 Velocity-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| | ● bit 8: Target control mode extension of Obj.607Fh:00h “Max profile velocity”<br>0: Standard specifications (pp, hm, ip, pv)<br>1: Extended specifications (pp, hm, ip, pv, tq, cst) | | | | | | | | | |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv<br>tq<br>cst | Yes | B |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td colspan="11">● Sets the velocity limit value.<br>● The maximum value is limited with Obj.6080h:00h “Max motor speed” by internal processing.<br>● When Obj.3697h:00h “Function expansion setup 3” :bit 8 is set to 0, the supported control modes are pp, hm, ip, and pv.<br>When Obj.3697h:00h “Function expansion setup 3” :bit 8 is set to 1, the supported control modes are pp, hm, ip, pv, tq, and cst.</td></tr>
<tr><td>6080h</td><td>00h</td><td>Max motor speed</td><td>r/min</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">● Sets the maximum motor speed.<br>● The maximum value is limited to the maximum velocity output by the motor using internal processing.</td></tr>
<tr><td>6081h</td><td>00h</td><td>Profile velocity</td><td>Command unit/s</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>pp<br>ip</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the target speed.<br>● The maximum value is limited by internal processing to the smaller of Obj.607Fh:00h “Max profile velocity” or Obj.6080h:00h “Max motor speed” .</td></tr>
<tr><td>6082h</td><td>00h</td><td>End velocity</td><td>Command unit/s</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>pp<br>ip</td><td>Yes</td><td>X</td></tr>
<tr><td colspan="11">● Sets the end speed.<br>● Not supported by this product and always returns 0.</td></tr>
<tr><td>60B1h</td><td>00h</td><td>Velocity offset</td><td>Command unit/s</td><td>-2147483648 to 2147483647</td><td>I32</td><td>rw</td><td>RxPDO</td><td>pp<br>hm<br>ip<br>pv<br>csp<br>csv</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Set the speed command offset value (speed feedforward).<br>● The maximum value is limited with Obj.6080h:00h “Max motor speed” by internal processing.</td></tr>
</table>

#### 6.6.5.1.1.3 Torque-related

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4312h</td><td>00h</td><td>Velocity control loop torque limit</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>No</td><td>A</td></tr>
<tr><td colspan="11">● If Obj.60FEh:01h “Physical outputs” :bit 19 = 1 is set while Obj.60FEh:02h “Bit mask” :bit 19 = 1, the set value limits the torque command value generated by the velocity control loop.</td></tr>
<tr><td>6072h</td><td>00h</td><td>Max torque</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the maximum motor torque.<br>● The maximum value is limited to the maximum torque output by the motor using internal processing.<br>● The maximum motor torque may vary depending on the motor used.<br>● Disabled if ESM state is Init, enabled if ESM state is PreOP or higher.</td></tr>
<tr><td>60B2h</td><td>00h</td><td>Torque offset</td><td>0.1%</td><td>-32768 to 32767</td><td>I16</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Set the torque command offset value (torque feedforward).<br>● The torque feedforward value is 0 during deceleration in over-travel inhibition operations (during emergency stops).</td></tr>
<tr><td>60E0h</td><td>00h</td><td>Positive torque limit value</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the positive direction torque limit when Obj.3521h:00h “Selection of torque limit” = 5 is set.<br>Limit the torque command by the smallest value among the limit values of Obj.3013h:00h “1st torque limit” , Obj.3522h:00h “2nd torque limit” and Obj.6072h:00h “Max torque” .</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| | • Sets the negative direction torque limit when Obj.3521h:00h “Selection of torque limit” = 5 is set.<br>Limit the torque command by the smallest value among the limit values of Obj.3013h:00h “1st torque limit” , Obj.3522h:00h “2nd torque limit” and Obj.6072h:00h “Max torque” . | | | | | | | | | |

### 6.6.5.1.1.4 Acceleration/Deceleration-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6083h | 00h | Profile acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv | Yes | A |
| | • Sets the profile acceleration.<br>• If set to 0, treated as 1 by internal processing. | | | | | | | | | |
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv<br>csp<br>csv | Yes | A |
| | • Sets the profile deceleration.<br>• In cyclic position control mode (csp) and cyclic velocity control mode (csv), it is valid only during deceleration stop sequences.<br>• If set to 0, treated as 1 by internal processing. | | | | | | | | | |
| 60C5h | 00h | Max acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| | • Sets the maximum acceleration.<br>• If set to 0, treated as 1 by internal processing. | | | | | | | | | |
| 60C6h | 00h | Max deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| | • Sets the maximum deceleration.<br>• If set to 0, treated as 1 by internal processing. | | | | | | | | | |

### 6.6.5.1.1.5 Software position limit (607Dh)

Sets the operating range (software limit) of the motor with Obj.607Dh: “Software position limit” .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Dh | — | Software position limit | — | — | — | — | — | — | — | — |
| | • Sets the software limit value. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Dh | 00h | Number of entries | — | 2 | U8 | ro | No | pp<br>ip<br>csp | No | X |
| | ● Displays the number of sub-indexes in Obj.607Dh: “Software position limit” . | | | | | | | | | |
| 607Dh | 01h | Min position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P<br>H |
| | ● Sets the software limit value for the negative direction. | | | | | | | | | |
| 607Dh | 02h | Max position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P<br>H |
| | ● Sets the software limit value in the positive direction. | | | | | | | | | |

- Setting unit

  Obj.607Dh: “Software position limit” is set in command units. Therefore, as with Obj.6062h:00h “Position demand value” , etc., set the value with Obj.607Ch:00h “Home offset” taken into account. For Home offset, see *“6.6.8.4 Position Information”* .

- Enabling

  To enable the software limit function, the following conditions must be met.

  - Must be in position control mode (pp, ip, csp)
  - The relationship between object setting values must satisfy Obj.607Dh:01h “Min position limit” < Obj.607Dh:02h “Max position limit”

  When used in incremental mode, the software limit function is disabled when the ESM state changes from Init to PreOP, so perform the homing operation again.

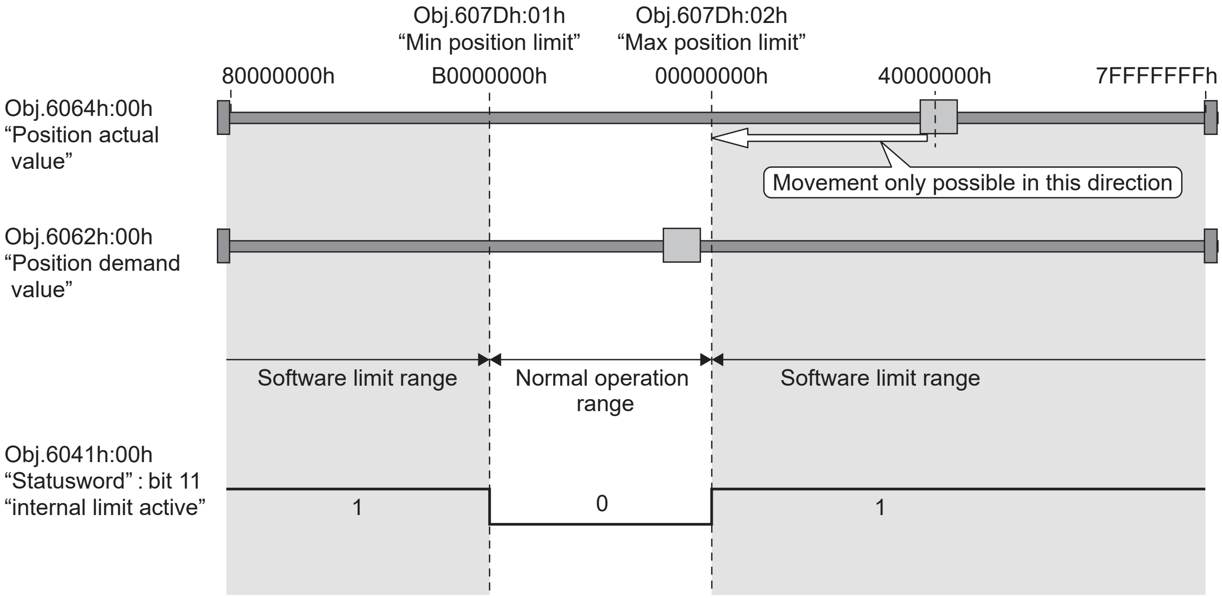
  If homing must be performed multiple times in succession, perform mode switching before executing homing.

  When the homing operation is executed in the absolute mode, the software limit function is disabled until normal completion.

  Set the actual position and command position to be between Obj.607Dh:01h “Min position limit” and Obj.607Dh:02h “Max position limit” (normal operating range) when initializing position information.

  If the actual position and command position is not within the normal operating range, as an exception, it can be moved only in the direction where the actual position falls within the normal operating range (It cannot move in the opposite direction).

  Obj.6041h:00h “Statusword” :bit 11 “internal limit active” is set to 1 (cause is internal limitation) until it falls within the normal operating range.



- Disabling

  To disable the software limit function, change the setup values of each object to the following conditions.

  Obj.607Dh:01h “Min position limit” ≥ Obj.607Dh:02h “Max position limit”

  (Example)

  Obj.607Dh:01h “Min position limit” = 0

  Obj.607Dh:02h “Max position limit” = 0

- Wraparound operation

  If you want to perform wraparound operation, disable the software limit function. When the software limit function is enabled, Err88.3.0 “Improper operation error protection” occurs if the actual or command position wraps around.

  Also, Obj.6041h:00h “Statusword” :bit 11 “internal limit active” is undefined.

- Operation at limit detection

  Deceleration starts according to the quick stop ramp when the actual position or command position detects a software limit during motor operation. However, in csp control mode, deceleration start may be delayed depending on the timing of command division.

  quick stop ramp: setting Obj.605Ah:00h “Quick stop option code” = 2, 6

### 6.6.5.1.1.6 Other

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| | ● bit 7: TFF clear ON/OFF selection from host device<br>0: Clear<br>1: Updates using the Obj.60B2h set value | | | | | | | | | |

### 6.6.5.1.2 Objects Commonly Related to Position Control (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F01h | 00h | Following error actual value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F04h | 00h | Position command internal value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F0Ch | 00h | Velocity command value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F0Dh | 00h | External scale position | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F41h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | — |
|  | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
|  | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| 4F48h | 00h | External scale pulse total | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F49h | 00h | External scale absolute position | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F87h | 00h | External scale data (Higher) | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F88h | 00h | External scale data (Lower) | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FFFh | 00h | Target position echo | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6065h | 00h | Following error window | Command unit | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>csp | Yes | A |
| 6066h | 00h | Following error time out | ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>csp | Yes | A |
| 6067h | 00h | Position window | Command unit | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6068h | 00h | Position window time | ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>ip | Yes | A |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN·m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |

There are other objects associated with each position control mode. For related objects, see below.

- *“6.6.5.2 Profile Position Control Mode (pp mode)”*
  1. *“6.6.5.2.1 Objects Related to pp Control Mode (Command/Setting-related)”*
  2. *“6.6.5.2.2 Objects Related to pv Control Mode (Monitoring-related)”*
- *“6.6.5.3 Cyclic Position Control Mode (csp mode)”*
  1. *“6.6.5.3.1 Objects Related to csp Control Mode (Command/Setting-related)”*
  2. *“6.6.5.3.2 Objects Related to csp Control Mode (Monitoring-related)”*
- *“6.6.5.5 Homing Position Control Mode (hm mode)”*
  1. *“6.6.5.5.1 Objects Related to hm Control Mode (Command/Setting-related)”*
  2. *“6.6.5.5.2 Objects Related to hm Control Mode (Monitoring-related)”*

### 6.6.5.1.2.1 Position-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F01h | 00h | Following error actual value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
|  | ● Displays position deviation (after filter). |  |  |  |  |  |  |  |  |  |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F04h | 00h | Position command internal value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | ● Displays the internal command position (after filter). | | | | | | | | | |
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays position information for the external scale. | | | | | | | | | |
| 4F41h | — | Motor encoder data | — | — | — | — | — | — | — | — |
| | ● Displays position information. | | | | | | | | | |
| 4F41h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of sub-indexes in Obj.4F41h: “Motor encoder data” . | | | | | | | | | |
| 4F41h | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the mechanical angle of the motor (single-turn encoder data). | | | | | | | | | |
| 4F41h | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays multi-turn data of the absolute encoder. | | | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the electrical angle of the motor. | | | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the external scale pulse sum. | | | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the absolute position of the external scale. | | | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the upper 24 bits of the external scale data. | | | | | | | | | |
| 4F88h | 00h | External scale data (Lower) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the lower 24 bits of the external scale data. | | | | | | | | | |
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>ip<br>hm<br>csp | No | X |
| | ● Displays the command position (= IPOS). | | | | | | | | | |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the actual position of the motor.<br>Encoder units except for full-closed control, and external scale units during full-closed control. | | | | | | | | | |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the actual position of the motor. In full-closed control, it is the external scale position. | | | | | | | | | |

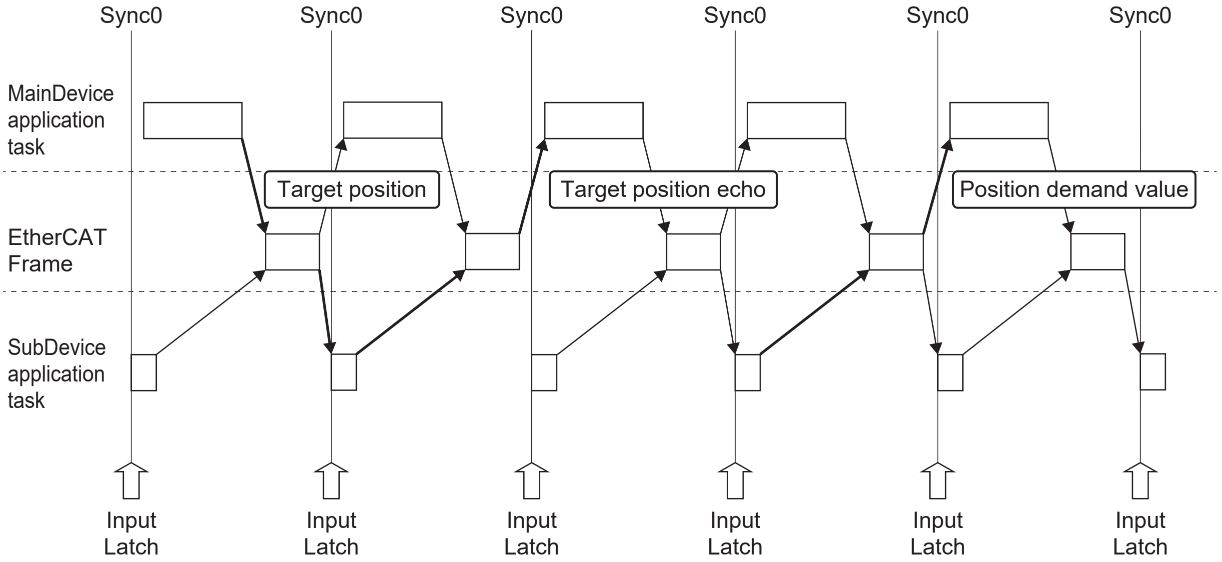
| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60F4h | 00h | Following error actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>ip<br>hm<br>csp | No | X |
| | | • Displays position deviation. | | | | | | | | |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>ip<br>hm<br>csp | No | X |
| | | • Displays the internal command position. | | | | | | | | |

### 6.6.5.1.2.2 Target position echo (4FFFh)

Displays the echo back value of Obj.607Ah:00h “Target position” .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FFFh | 00h | Target position echo | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | • Displays the value of Obj.607Ah:00h “Target position” . | | | | | | | | |

Reference: Difference in reply timing between Target position echo and Position demand value



### 6.6.5.1.2.3 Velocity-related

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4F0Ch</td><td>00h</td><td>Velocity command value (after filtering)</td><td>r/min</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>pp<br>hm<br>csp</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays command speed (after filter).</td></tr>
<tr><td>4FA1h</td><td>00h</td><td>Velocity command value</td><td>r/min</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the velocity control command.</td></tr>
<tr><td>4FA5h</td><td>00h</td><td>Velocity internal position command</td><td>r/min</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>pp<br>hm<br>csp</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the internal position command speed.</td></tr>
<tr><td>4FA6h</td><td>00h</td><td>Velocity error actual value</td><td>r/min</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>pp<br>hm<br>csp</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the speed deviation.</td></tr>
<tr><td>6069h</td><td>00h</td><td>Velocity sensor actual value</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the actual speed sensor value.<br>Not supported by this product and always returns 0.</td></tr>
<tr><td>606Ch</td><td>00h</td><td>Velocity actual value</td><td>Command unit/s</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the actual speed (= FSPD) of the motor.</td></tr>
<tr><td>60FAh</td><td>00h</td><td>Control effort</td><td>Command unit/s</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>pp<br>ip<br>hm<br>csp</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays internal command speed (output of position loop).</td></tr>
</table>

### 6.6.5.1.2.4 Torque-related

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4D29h</td><td>00h</td><td>Over load factor</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the overload load factor (ratio of motor rated load).</td></tr>
<tr><td>4F11h</td><td>00h</td><td>Regenerative load ratio</td><td>%</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the regenerative load factor (the ratio of regenerative overload protection to the level of alarm occurrence).</td></tr>
<tr><td>4F31h</td><td>00h</td><td>Inertia ratio</td><td>%</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the inertia ratio.<br>Ratio of load inertia to motor rotor inertia (equivalent to the value of 3004h)<br>Inertia ratio = (Load inertia/Rotor inertia) × 100</td></tr>
<tr><td>4FA8h</td><td>00h</td><td>Positive direction torque limit value</td><td>0.05%</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the torque limit value in the positive direction.</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the negative direction. | | | | | | | | |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | | ● Indicates the internal command torque. | | | | | | | | |
| 6076h | 00h | Motor rated torque | mN·m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| | | ● The rated torque is read from the motor and set automatically. | | | | | | | | |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual torque.<br>● It is equivalent to the actual current value.<br>● This output value is for reference only and does not guarantee the actual value. | | | | | | | | |

### 6.6.5.1.2.5 Statusword (6041h) (Position Control Common Functions)

This section describes the following functions.

- bit 10 “target reached” (Positioning complete detection)
- bit 13 “following error” (Position deviation excess detection)

For more information on this and other features, see the “Related Objects” section for each position control mode below.

- *“6.6.5.2 Profile Position Control Mode (pp mode)”*
  1. *“6.6.5.2.1 Objects Related to pp Control Mode (Command/Setting-related)”*
  2. *“6.6.5.2.2 Objects Related to pv Control Mode (Monitoring-related)”*
- *“6.6.5.3 Cyclic Position Control Mode (csp mode)”*
  1. *“6.6.5.3.1 Objects Related to csp Control Mode (Command/Setting-related)”*
  2. *“6.6.5.3.2 Objects Related to csp Control Mode (Monitoring-related)”*
- *“6.6.5.5 Homing Position Control Mode (hm mode)”*
  1. *“6.6.5.5.1 Objects Related to hm Control Mode (Command/Setting-related)”*
  2. *“6.6.5.5.2 Objects Related to hm Control Mode (Monitoring-related)”*

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Sets control commands for this product, such as PDS state transitions.

Bit data reference

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2">(1)</td><td colspan="2">(2)</td><td rowspan="2">(3)</td><td>(2)</td><td rowspan="2">(4)</td><td rowspan="2">(1)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td><td rowspan="2">(9)</td><td rowspan="2">(10)</td><td rowspan="2">(11)</td><td rowspan="2">(12)</td></tr>
<tr><td>(13)</td><td>(*1)</td><td>(14)</td></tr>
</table>

*1 (Varies by control mode)

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): following error (pp, csp only)
(14): target reached (excluding csp)

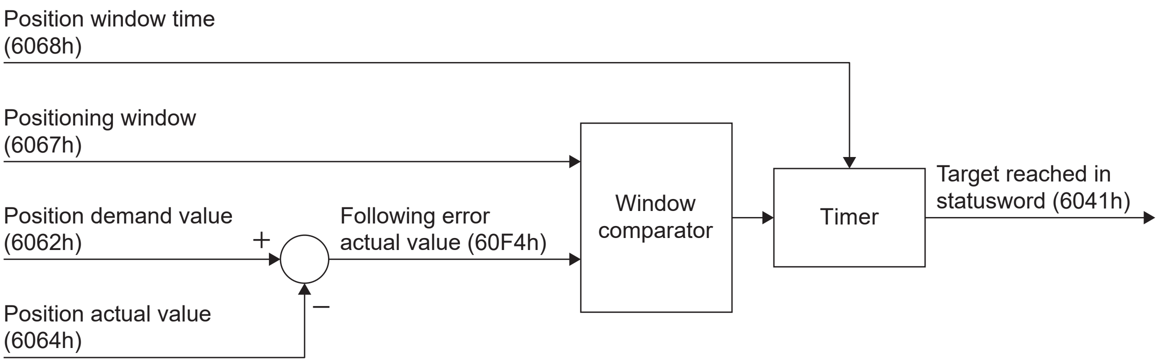
### ■ Bit 10: target reached (Position reached)

If all of the following conditions are met, Obj.6041h:00h “Statusword” :bit 10 “target reached” is 1.

- Servo-on state (Operation enable state)
- State in which all set-points have been allocated and command generation has been completed
- If the difference between Obj.6062h:00h “Position demand value” and Obj.6064h:00h “Position actual value” is within the range set in Obj.6067h:00h “Position window”
- When the time set in Obj.6068h:00h “Position window time” has elapsed

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt = 0 (during normal operation): Positioning not complete<br>halt = 1 (when stopped by halt): Axis decelerating |
| | | 1 | halt = 0 (during normal operation): Positioning complete<br>halt = 1 (when stopped by halt): Axis stopped (axis speed is 0) |

**Position reached (functional overview)**



| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6067h | 00h | Position window | Command unit | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| | | ● Sets the threshold value at which the difference between Obj.6062h:00h “Position demand value” and Obj.6064h:00h “Position actual value” is within the set value of this parameter and Obj.6041h:00h “Statusword” :bit 10 “target reached” becomes 1 when the time set in Obj.6068h:00h “Position window time” elapses.<br>If the difference between Obj.6062h:00h “Position demand value” and Obj.6064h:00h “Position actual value” is outside the setting of this parameter, Obj.6041h:00h “Statusword” :bit 10 “target reached” will be 0. | | | | | | | | |
| 6068h | 00h | Position window time | 1 ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>ip | Yes | A |
| | | ● Sets the time until Obj.6041h:00h “Statusword” :bit 10 “target reached” becomes 1 when the difference between Obj.6062h:00h “Position demand value” andObj.6064h:00h “Position actual value” is within the range set in Obj.6067h:00h “Position window” . | | | | | | | | |

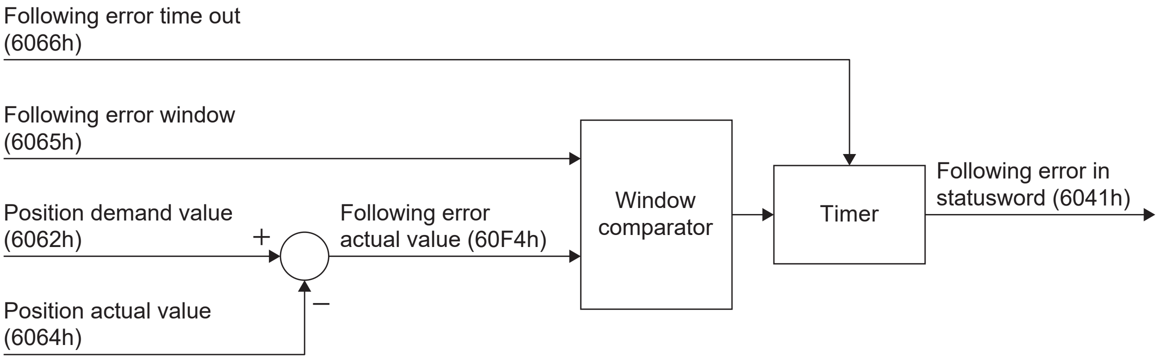
For Positioning Complete Output (INP/INP2) Function, see Technical Reference Functional Specification “3.1.5 Positioning Complete Output (INP/INP2) Signal” .

## ■ bit 13: following error

If the value of Obj.60F4h:00h “Following error actual value” exceeds the setting range of Obj.6065h:00h “Following error window” for the time set in Obj.6066h:00h “Following error time out” , Obj.6041h:00h “Statusword” :bit 13 “following error” is set to 1.

| bit | Name | Value | Definition |
|---|---|---|---|
| 13 | following error | 0 | The value of Obj.60F4h:00h “Following error actual value” (=Obj.6062h:00h “Position demand value” to Obj.6064h:00h “Position actual value” ) does not exceed the set range of Obj.6065h:00h “Following error window” , or the value of Obj.60F4h:00h “Following error actual value” exceeds the set value of Obj.6065h:00h “Following error window” , but the time set in Obj.6066h:00h “Following error time out” has not elapsed. |
| | | 1 | The value in Obj.60F4h:00h “Following error actual value” exceeds the set range in Obj.6065h:00h “Following error window” for more than the time set in Obj.6066h:00h “Following error time out” . |

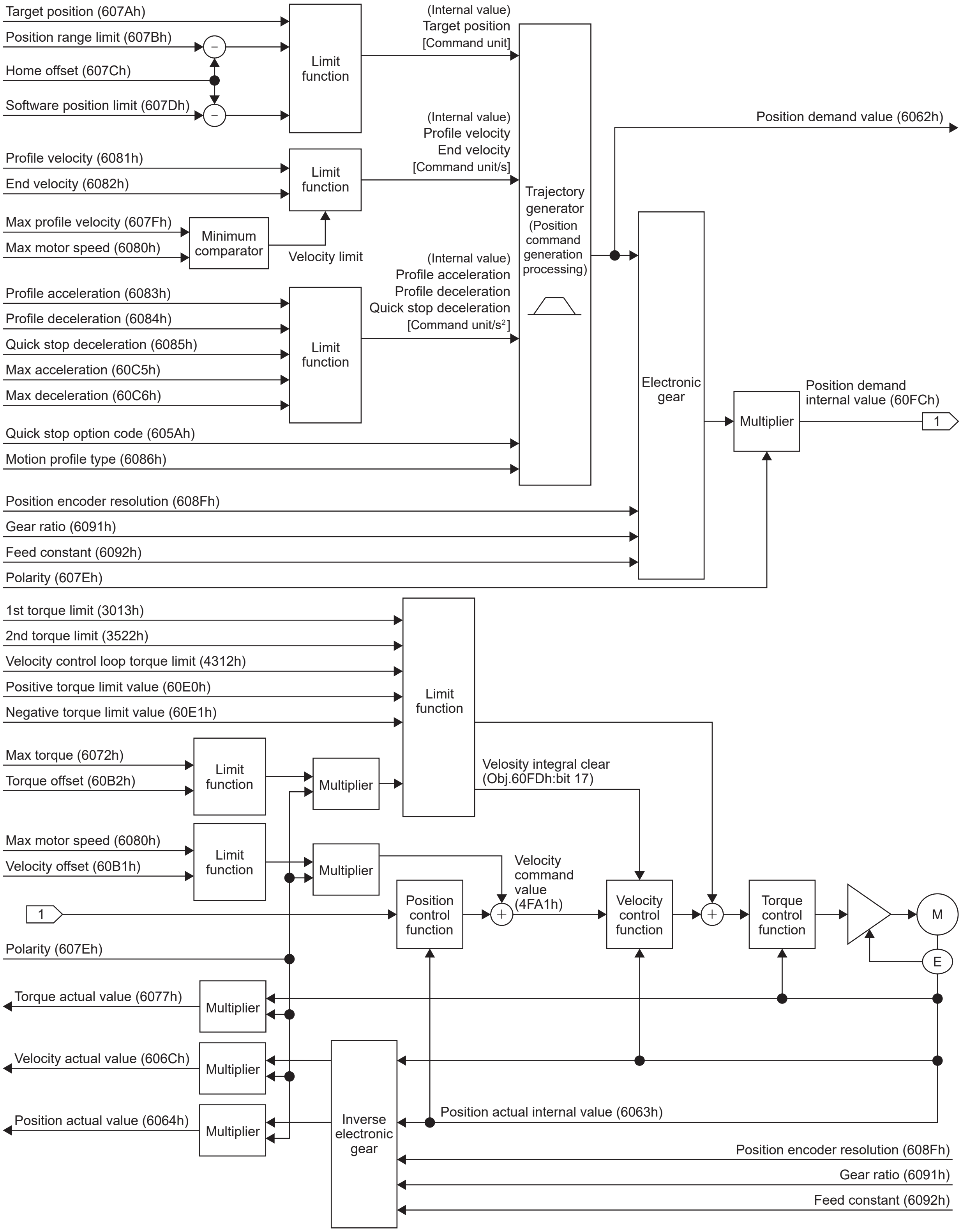
### Following error (functional overview)



| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6065h | 00h | Following error window | Command unit | 0 to 4294967295 | U32 | rw | RxPDO | pp | Yes | A |
| | ● Sets the threshold at which Obj.6041h:00h “Statusword” :bit 13 “following error” becomes 1 if the value of Obj.60F4h:00h “Following error actual value” is outside the setting of this parameter. | | | | | | | | | |
| 6066h | 00h | Following error time out | ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>csp | Yes | A |
| | ● Sets the threshold value at which Obj.6041h:00h “Statusword” :bit 13 “following error” becomes 1 if the value of Obj.60F4h:00h “Following error actual value” continues to exceed the setting range of Obj.6065h:00h “Following error window” for more than the setting value of this parameter. | | | | | | | | | |

### 6.6.5.2 Profile Position Control Mode (pp mode)

Profile position control (pp) is a control mode in which the host device commands the target position, target speed, and acceleration/deceleration (parameters), and the product generates position commands internally.



#### 6.6.5.2.1 Objects Related to pp Control Mode (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60F2h | 00h | Position option code | — | 0 to 65535 | U16 | rw | RxPDO | pp | Yes | A |

There are other related objects commonly used for position control. For details, see *"6.6.5.1 Position Control Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 607Ah | 00h | Target position | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>csp | No | A |
| 607Dh | — | Software position limit | — | — | — | — | — | pp<br>ip<br>csp | — | — |
|  | 00h | Number of entries | — | 2 | U8 | ro | No | pp<br>ip<br>csp | No | X |
|  | 01h | Min position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P<br>H |
|  | 02h | Max position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P<br>H |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes | B |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 6081h | 00h | Profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6082h | 00h | End velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | X |
| 6083h | 00h | Profile acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| 6084h | 00h | Profile deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60C5h | 00h | Max acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 60C6h | 00h | Max deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | — | Position range limit | — | — | — | — | — | ALL | — | — |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
|  | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6085h | 00h | Quick stop deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6086h | 00h | Motion profile type | — | -32768 to 32767 | I16 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 60A3h | 00h | Profile jerk use | — | 1 to 2, 255 | U8 | rw | No | pp<br>pv<br>ip | Yes | A |
| 60A4h | — | Profile jerk | — | — | — | — | — | pp<br>pv<br>ip | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | pp<br>pv<br>ip | No | X |
| | 01h | Profile jerk1 | Command unit/$s^3$ | 0 to 4294967295 | U32 | rw | No | pp<br>pv<br>ip | Yes | A |
| | 02h | Profile jerk2 | Command unit/$s^3$ | 0 to 4294967295 | U32 | rw | No | pp<br>pv<br>ip | Yes | A |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60FEh | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

### 6.6.5.2.1.1 Controlword (6040h) (Functions in pp Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands for this product, such as PDS state transitions.

Bit data reference

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="6" rowspan="2">(1)</td><td>(2)</td><td rowspan="2">(3)</td><td rowspan="2">(4)</td><td colspan="3">(2)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td></tr>
<tr><td>(9)</td><td>(10)</td><td>(11)</td><td>(12)</td></tr>
</table>

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on
(9): change on set-point
(10): absolute / relative
(11): change set immediately
(12): new set-point

### ■ Bit 9, 6 to 4 (operation mode specific (control mode dependent bit)):

| bit | Name | Value | Definition |
|---|---|---|---|
| 4 | new set-point | 0 to 1 | Trigger for starting positioning operation and updating set value.<br>Import a new positioning task (Obj.607Ah:00h “Target position” , (Obj.6081h:00h “Profile velocity” , etc.). |
| 5 | change set immediately | 0 | After the current positioning operation is completed, the next positioning operation is started. |
|  |  | 1 | The current positioning operation is interrupted and the next positioning operation is started immediately.<br>Additional options for operation switch timing are set in Obj.60F2h:00h “Position option code” :bit 3 to 2 “change immediately option” . |
| 6 | absolute / relative | 0 | Treat Obj.607Ah:00h “Target position” as an absolute position. |
|  |  | 1 | Treat Obj.607Ah:00h “Target position” as a relative position.<br>Additional options for relative positioning are set in Obj.60F2h:00h “Position option code” :bit 1 to 0 “relative option” . |
| 9 | change on set-point | — | See the following table<br>Not supported in this software version. |

The table below shows the differences in operation from combinations of bit 9, bit 5, and bit 4.

| bit 9 | bit 5 | bit 4 | Definition |
|---|---|---|---|
| change on set-point | change set immediately | new set-point | |
| 0 | 0 | 0 to 1 | The next positioning operation is executed after the current positioning operation is completed.<br>(See *"Operation example 1 (basic set-point)"* or *"Operation example 3 (data change during operation with buffer: set of set-points)"* in *"6.6.5.2.3 Operation in pp Control Mode"* ) |
| – | 1 | 0 to 1 | The next positioning operation is performed immediately.<br>(See *"Operation example 1 (basic set-point)"* or *"Operation example 2 (data change during operation without buffer: single set-point)"* in *"6.6.5.2.3 Operation in pp Control Mode"* ) |
| 1 | 0 | 0 to 1 | After a positioning operation is executed at the current profile speed to the current target position, upon completion, the next positioning operation is executed.<br>(See *"Operation example 1 (basic set-point)"* or *"Operation example 3 (data change during operation with buffer: set of set-points)"* in *"6.6.5.2.3 Operation in pp Control Mode"* )<br>Not supported in this software version. |

**— Precautions —**

- Do not change the acceleration/deceleration with the following objects while the motor is running.

  To change the acceleration/deceleration, change bit 4 "new set-point" from 0 to 1 after the motor stops.
  - Obj.6083h:00h "Profile acceleration"
  - Obj.6084h:00h "Profile deceleration"
  - Obj.60C5h:00h "Max acceleration"
  - Obj.60C6h:00h "Max deceleration"
- If a set-point is executed (bit 4 "new set-point" is changed from 0 to 1) under the following conditions, the positioning task is discarded.
  - Set-point at Obj.6081h:00h "Profile velocity" = 0
  - Set-point in the direction that does not leave from a restricted state with software limits
  - Set-point in the direction that does not leave from a restricted state by a drive prohibition
- All positioning tasks are discarded if any of the following conditions occur.
  - When over-travel inhibit is detected during deceleration by halt = 1
  - When a positioning task that operates in the opposite direction of the positioning task being executed is buffered and over-travel inhibit is detected
- Allow 2 ms between starting a pp operation and starting the next pp operation (changing bit 4 "new set-point" from 0 to 1).
- When stopped by halt, the settings of Obj.6040h:00h "Controlword" :bits 5 and 9 and Obj.60F2h:00h "Position option code" in the positioning task being executed (during halt) are cleared internally (set value 0).

### 6.6.5.2.1.2 Position option code (60F2h)

This object is an additional option that determines the operation specifications for positioning operation in pp mode.

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60F2h | 00h | Position option code | – | 0 to 65535 | U16 | rw | RxPDO | pp | Yes | A |

- Sets the operation specifications for positioning operation.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | | | | | | | | | (3) | | (4) | | (5) | |

(1): manufacturer-specific
(2): reserved
(3): request-response option
(4): change immediately option
(5): relative option

## ■ Bit 1 to 0 (relative option):

Set Obj.6040h:00h “Controlword” :bit 6 “absolute / relative” to 1 to determine the operation specifications for the relative positioning operation. Normally used in mode 0.

| bit 1 | bit 0 | Relative positioning mode | Definition |
|---|---|---|---|
| 0 | 0 | Mode 0 | Operates relative to the target position (absolute coordinate values) of the previous operation. (*1)<br>If there is no target position in the immediately preceding operation, or after execution in another control mode, etc., the operation is relative to the absolute coordinate value 0.<br>After execution in other control modes, the previous target position is discarded. |
| 0 | 1 | Mode 1 | Operates relative to Obj.6062h:00h “Position demand value” (= trajectory generator output value). (*2) |
| 1 | 0 | Mode 2 | Operates relative to Obj.6064h:00h “Position actual value” . (*2) |
| 1 | 1 | Mode 3 | reserved |

*1 When a positioning operation is started after the previous operation was interrupted by over-travel inhibit detection or Quickstop, the target position is the relative position of the target position of the previous operation.

In this case, the direction of operation is the direction in which the distance from the command position at the point of interruption to the next target position is the shortest.

Note that if the difference between the next target position and the command position at the point of interruption falls outside the range of -2147483648 to 2147483647, the operation will move in the opposite direction of the sign of the set relative position.

If this behavior is problematic for applications that operate in the same direction and are frequently interrupted, use Mode 1.

*2 The expected position may not be arrived at due to propagation delays, etc.

## ■ Bit 3 to 2 (cio (change immediately option)):

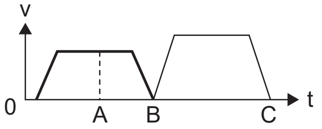
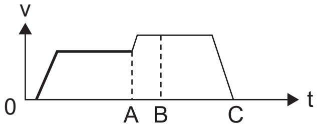
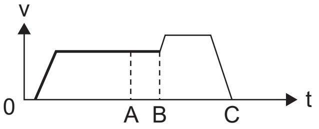
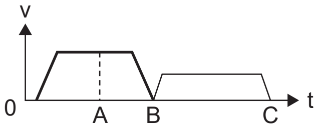
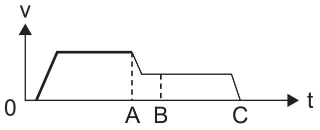
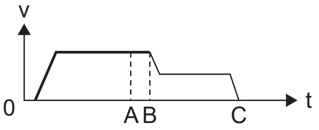
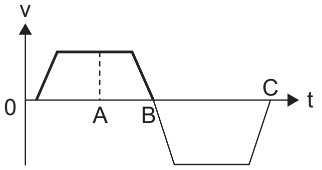
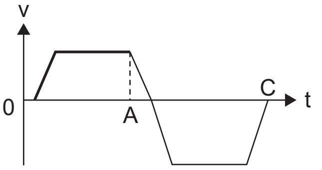
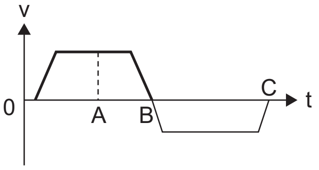
Set Obj.6040h:00h “Controlword” :bit 5 “change set immediately” to 1 to determine the operation specification when immediately starting the next positioning operation.

This software version is supported only when bits 3 and 2 are both 0. Do not set to a value other than 0.

| bit 3 | bit 2 | Definition |
|---|---|---|
| 0 | 0 | Immediately update the behavior to the new positioning task (including changes to profile velocity, acceleration, etc.). |

| bit 3 | bit 2 | Definition |
|---|---|---|
| 0 | 1 | New positioning tasks (including changes to profile velocity, acceleration, etc.) operate as a continuation of the currently executing positioning task (The operation continues without stopping on the target position of the positioning task currently being executed.).<br>Not supported in this software version. |
| 1 | 0 | reserved |
| 1 | 1 | reserved |

The table below shows the operation pattern for the combination of Obj.6040h:00h “Controlword” :bit 5 “change set immediately” and Obj.60F2h:00h “Position option code” :bit 3 to 2 “change immediately option” .

| Obj.6040h:00h:bit 5 “change set immediately” | 0 | | 1 | |
|---|---|---|---|---|
| Obj.60F2h:00h:bit 3 to 2 “change immediately option” | 00 | 01<br>(Not Supported) | 00 | 01<br>(Not Supported) |
| If the target position is updated in the same direction and the speed is increased |  | |  |  |
| If the target position is updated in the same direction and the speed is reduced |  | |  |  |
| When the target position is updated in the opposite direction |  | | <br>*The previous target position is not reached. |  |

A: Timing of command change from main device

B: Timing of target position (before update) arrival

C: Timing of target position (after update) arrival

Bold line: Operates under the condition before command change

Thin line: Operates under the condition after the command is changed

### ■ Bit 5 to 4 (rro (request-response option)):

Normally, after the positioning operation is started, Obj.6040h:00h “Controlword” : bit 4 “new set-point” must be set to 0 by the main device, but this option allows the sub device side to set it to 0 automatically.

| bit 5 | bit 4 | Definition |
|---|---|---|
| 0 | 0 | Perform the handshake as shown in *“Operation example 1 (basic set-point)”* to *“Operation example 3 (data change during operation with buffer: set of set-points)”* of *“6.6.5.2.3 Operation in pp Control Mode”* . |
| 0 | 1 | The sub device automatically releases bit 4 “new set-point” as soon as the executing set-points have been allocated and command generation is complete (Set to 0). |
| 1 | 0 | The sub device automatically releases bit 4 “new set-point” as soon as it accepts the new target position (Set to 0). |
| 1 | 1 | reserved |

#### 6.6.5.2.2 Objects Related to pv Control Mode (Monitoring-related)

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | – | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

There are other related objects commonly used for position control. For details, see *“6.6.5.1 Position Control Common Functions”* .

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6065h | 00h | Following error window | Command unit | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>csp | Yes | A |
| 6066h | 00h | Following error time out | ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>csp | Yes | A |
| 6067h | 00h | Position window | Command unit | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip | Yes | A |
| 6068h | 00h | Position window time | ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>ip | Yes | A |
| 6069h | 00h | Velocity sensor actual value | – | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN・m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |

There are other related objects commonly used for motion. For details, see *“6.6.8 Motion Common Functions”* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

#### 6.6.5.2.2.1 Statusword (6041h) (Functions in pp Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | (2) | | (3) | (2) | (4) | (1) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | | (13) | (14) | | (15) | | | | | | | | | | |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): following error
(14): set-point acknowledge
(15): target reached

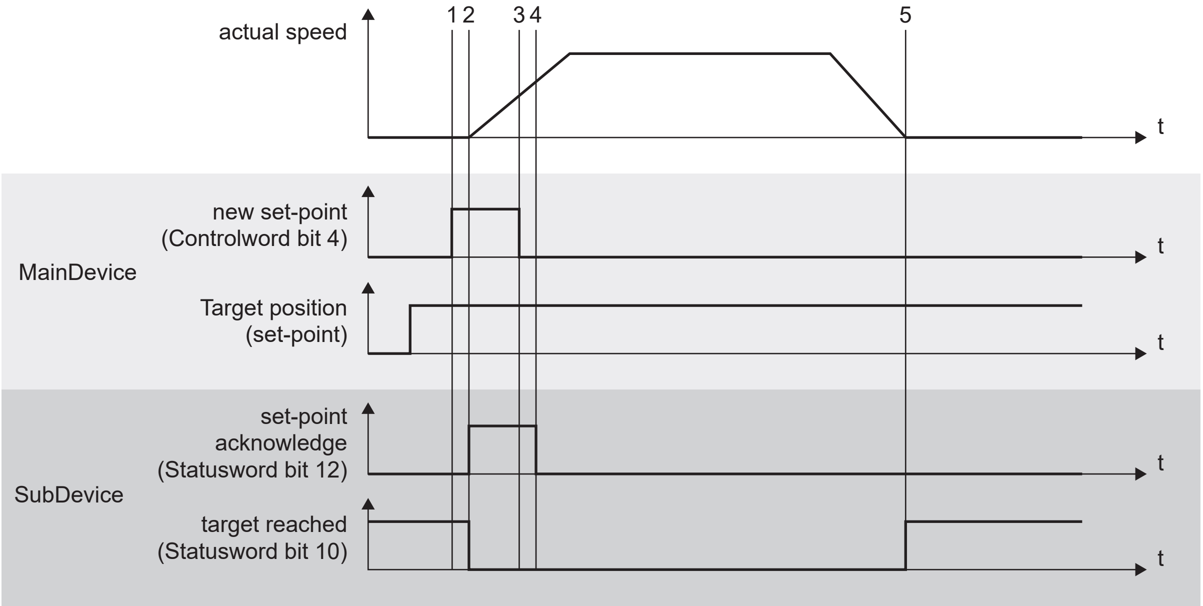
### ■ Bit 13, 12, 10 (operation mode specific (control mode dependent bit)):

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | — | See *"6.6.5.1.2.5 Statusword (6041h) (Position Control Common Functions)"* . |
| 12 | set-point acknowledge | 0 | new-setpoint is 0, an operation for the previous target position has been executed (or is being executed), and the buffer is empty |
| | | 1 | Buffer is not empty when data for a new positioning task is loaded into the buffer |
| 13 | following error | — | See *"6.6.5.1.2.5 Statusword (6041h) (Position Control Common Functions)"* . |

### 6.6.5.2.3 Operation in pp Control Mode

#### ■ Operation example 1 (basic set-point)

**Set-point example**



1 After setting the value of Obj.607Ah:00h “Target position” , the main device changes Obj.6040h:00h “Controlword” :bit 4 “new set-point” from 0 to 1 at least one communication cycle later. At this time, please also set Obj.6081h:00h “Profile velocity” .

When Obj.6081h:00h “Profile velocity” is 0, the motor does not operate.

2 The sub device confirms the rising edge (0 to 1) of Obj.6040h:00h “Controlword” :bit 4 “new set-point” and starts positioning operation with Obj.607Ah:00h “Target position” as the target position. At that time, change Obj.6041h:00h “Statusword” : bit 12 “set-point acknowledge” from 0 to 1.

3 The main device confirms that Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” has changed from 0 to 1 and sets Obj.6040h:00h “Controlword” :bit 4 “new set-point” back to 0.

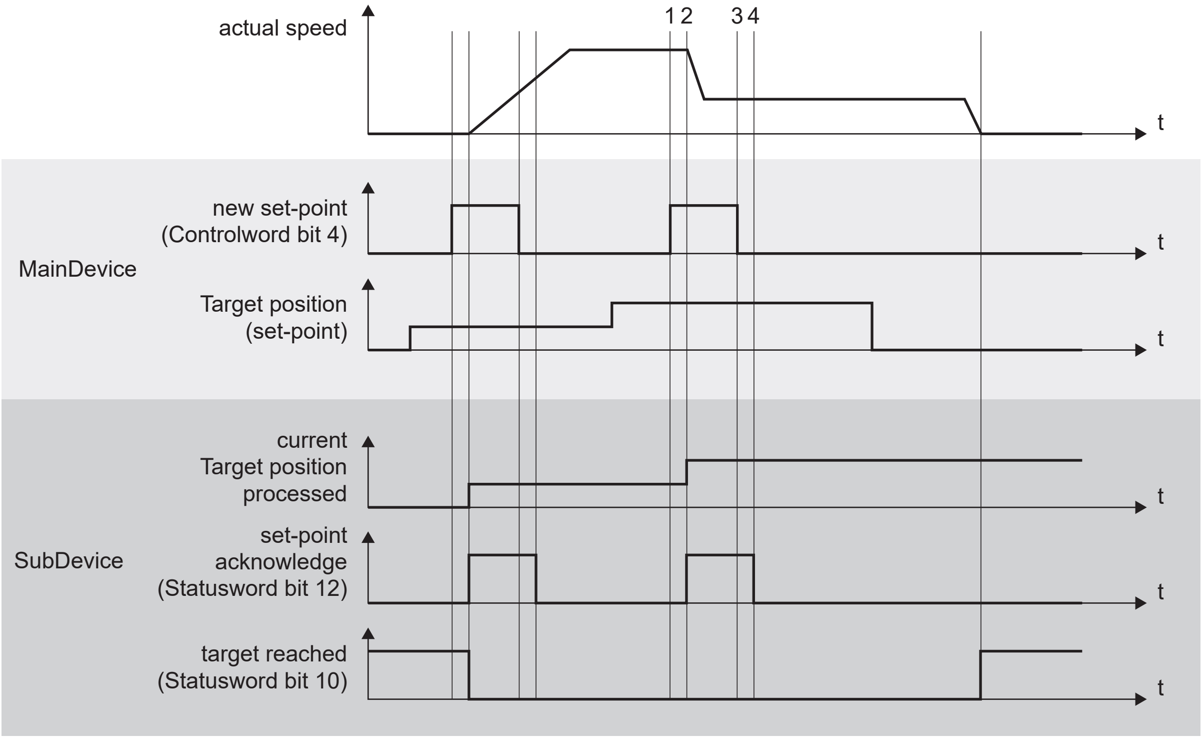
4 The sub device confirms that Obj.6040h:00h “Controlword” :bit 4 “new set-point” is now 0 and sets Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” to 0.

5 When the target position is reached, Obj.6041h:00h “Statusword” :bit 10 “target reached” is changed from 0 to 1.

## ■ Operation example 2 (data change during operation without buffer: single set-point)

When Obj.6040h:00h “Controlword” :bit 5 “change set immediately” is set to 1, if the data for positioning operation is changed during operation, the current positioning operation is aborted and the next positioning operation starts immediately.

### Handshaking procedure for the single set-point method



1 The main device confirms that Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” is 0, changes the value of Obj.607Ah:00h “Target position” , and then changes Obj.6040h:00h “Controlword” :bit 4 “new set-point” from 0 to 1 after one or more communication cycles.

**— Precautions —**

- At this time, do not change acceleration/deceleration.

2 The sub device checks the rising edge (0 to 1) of Obj.6040h:00h “Controlword” :bit 4 “new set-point” and immediately updates Obj.607Ah:00h “Target position” as the new target position. At that time, change Obj.6041h:00h “Statusword” : bit 12 “set-point acknowledge” from 0 to 1.

3 The main device confirms that Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” has changed from 0 to 1 and sets Obj.6040h:00h “Controlword” :bit 4 “new set-point” back to 0.

4 The sub device confirms that Obj.6040h:00h “Controlword” :bit 4 “new set-point” is now 0 and sets Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” to 0.

**Notes**

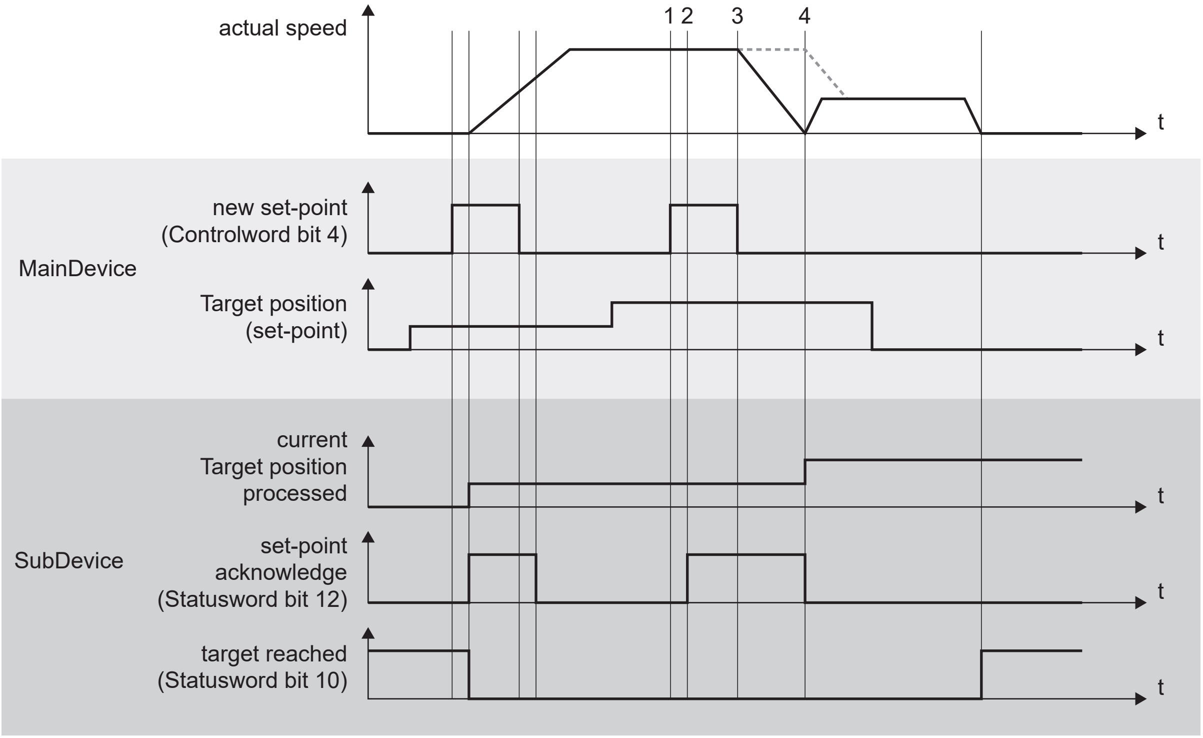
- The same procedure (“1” to “4”) can be used to change Obj.6081h:00h “Profile velocity” .

  After changing Obj.607Ah:00h “Target position” and Obj.6081h:00h “Profile velocity” , update Obj.607Ah:00h “Target position” and Obj.6081h:00h “Profile velocity” at the same time by following steps “1” through “4” above.

### ■ Operation example 3 (data change during operation with buffer: set of set-points)

When Obj.6040h:00h “Controlword” :bit 5 “change set immediately” is 0, if the data for positioning operation is changed during operation, the next positioning operation starts after the current positioning operation is completed.

**Handshaking procedure for the set of set-point method**



1 The main device confirms that Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” is 0, changes the value of Obj.607Ah:00h “Target position” , and then changes Obj.6040h:00h “Controlword” :bit 4 “new set-point” from 0 to 1 after one or more communication cycles.

**— Precautions —**

- At this time, do not change acceleration/deceleration.

2 The sub device checks the rising edge (0 to 1) of Obj.6040h:00h “Controlword” :bit 4 “new set-point” and buffers Obj.607Ah:00h “Target position” as the new target position. At that time, change Obj.6041h:00h “Statusword” : bit 12 “set-point acknowledge” from 0 to 1.

In this stage, positioning operation continues relative to the target position before the change.

3 The main device confirms that Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” has changed from 0 to 1 and sets Obj.6040h:00h “Controlword” :bit 4 “new set-point” back to 0.

4 The sub device confirms that Obj.6040h:00h “Controlword” :bit 4 “new set-point” is 0 and that the currently executed positioning operation is complete, and starts a positioning operation for a new target position.

Since the buffer is empty here, Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” is set to 0.

**Notes**

- The same procedure (“1” to “4”) can be used to change Obj.6081h:00h “Profile velocity” .

  After changing Obj.607Ah:00h “Target position” and Obj.6081h:00h “Profile velocity” , update Obj.607Ah:00h “Target position” and Obj.6081h:00h “Profile velocity” at the same time by following steps “1” through “4” above.

- The dashed line in the figure below shows the actual speed when Obj.6040h:00h “Controlword” :bit 9 “change on set-point” is set to 1.

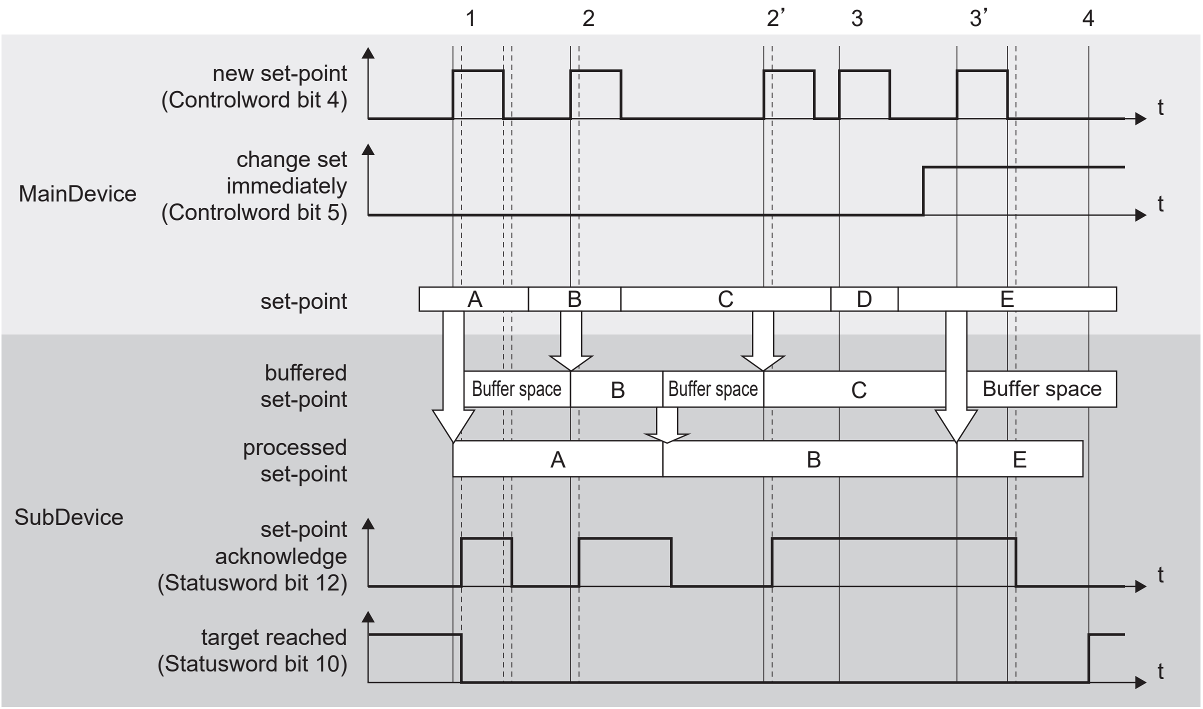
  However, if the new target position is front of the operation direction, the machine stops at the target position before the change and performs a reverse operation.

### ■ Operation example 4 (buffering of set-point)

There are two set-points: a set-point for execution and a set-point for buffering.

The handling of these set-points is shown in the figure below.

**Set-point handling for two set-points**



1 If a set-point is not being executed, the new set-point (A) takes effect immediately.

2 If a set-point is being executed, a new set-point (B or C) is stored if the set-point buffer is free.

3 If the set-point buffer is in use, that is, Obj.6041h:00h “Statusword” :bit 12 “set-point acknowledge” is 1, updating the set-point buffer depends on Obj.6040h:00h “Controlword” :bit 5 “change set immediately” .

If Obj.6040h:00h “Controlword” :bit 5 “change set immediately” is not set to 1, the new set-point (D) will be put on hold without being processed.

If Obj.6040h:00h “Controlword” :bit 5 “change set immediately” is set to 1, the new set-point (E) will be processed immediately. At this time, all set-points (B, C, D) loaded before Obj.6040h:00h “Controlword” :bit 5 “change set immediately” is set to 1 are discarded.

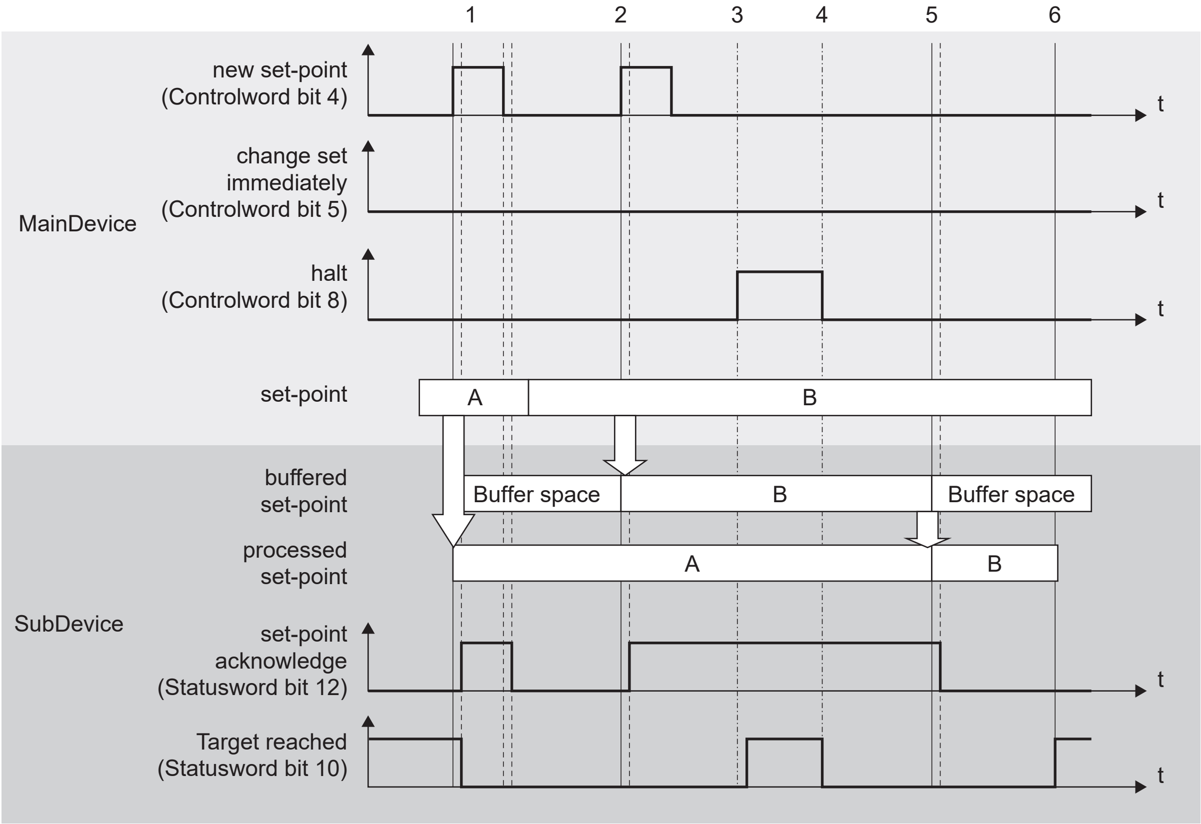
4 Until all set-points are processed, Obj.6041h:00h “Statusword” :bit 10 “target reached” will remain 0.

### ■ Operation example 5 (temporary stop by halt)

If Obj.6040h:00h “Controlword” :bit 8 “halt” becomes 1 during pp operation, there is a temporary stop of positioning operation and when bit 8 “halt” returns to 0, the positioning operation to the set-point for execution is resumed.

The handling of these set-points is shown in the figure below.

**Set-point handling for Resumption of positioning operation after pause by Obj.6040h:00h “Controlword” :bit 8 “halt”**

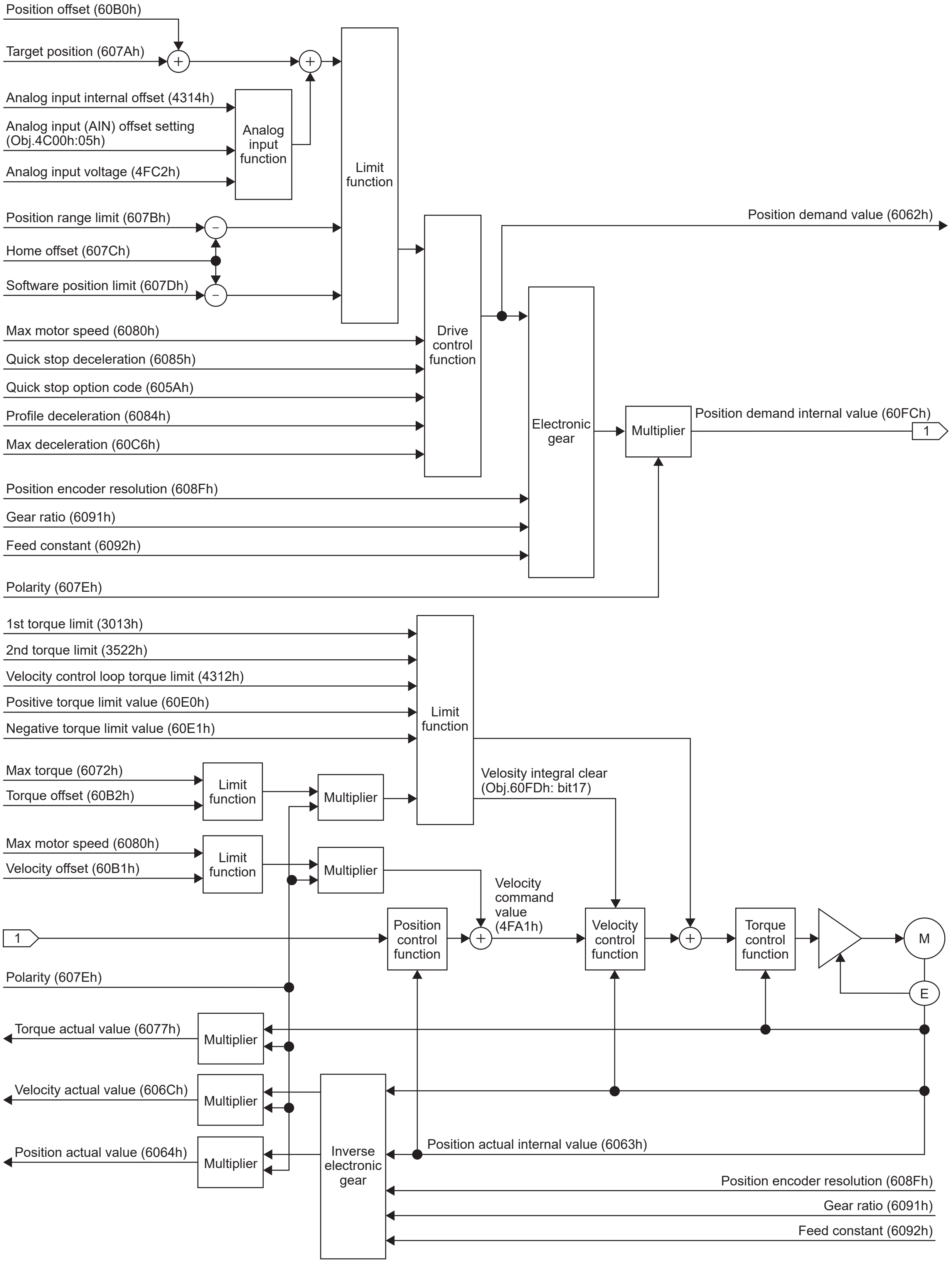


1 If a set-point is not being executed, the new set-point (A) takes effect immediately.
2 If set-point is running, a new set-point (B) is stored if the set-point buffer is free.
3 If Obj.6040h:00h “Controlword” :bit 8 “halt” is set to 1 while the first set-point (A) is running, the first set-point (A) will temporary stop. In this case, if a deceleration stop is performed and the speed becomes 0, Obj.6041h:00h “Statusword” :bit 10 “target reached” becomes 1.
4 After that, when Obj.6040h:00h “Controlword” :bit 8 “halt” is set to 0, the operation of the first set-point (A) is resumed. In this case, Obj.6041h:00h “Statusword” :bit 10 “target reached” becomes 0.
5 When the first set-point (A) operation completes, the new set-point (B) is processed.
6 Until all set-points are processed, Obj.6041h:00h “Statusword” : bit 10 “target reached” will remain as 0.

### 6.6.5.3 Cyclic Position Control Mode (csp mode)

Cyclic position control mode (csp mode) is a position control mode in which the host device generates position commands and updates (sends) the command position in a command update cycle.

Use in DC or SM2 synchronous mode.



#### 6.6.5.3.1 Objects Related to csp Control Mode (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60B0h | 00h | Position offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | A |
| 4314h | 00h | Analog input internal offset | mV | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 4351h | 00h | Analog input function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | B |
| 4C00h | 05h | Analog input (AIN) offset setting | 0.375 mV | -26666 to 26666 | I16 | rw | No | ALL | Yes | B |
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | R |
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |

There are other related objects commonly used for position control. For details, see *"6.6.5.1 Position Control Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 607Ah | 00h | Target position | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>csp | No | A |
| 607Dh | — | Software position limit | — | — | — | — | — | pp<br>ip<br>csp | — | — |
|  | 00h | Number of entries | — | 2 | U8 | ro | No | pp<br>ip<br>csp | No | X |
|  | 01h | Min position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P<br>H |
|  | 02h | Max position limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>ip<br>csp | Yes | P<br>H |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | — | Position range limit | — | — | — | — | — | ALL | — | — |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
|  | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |
| 6084h | 00h | Profile deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6085h | 00h | Quick stop deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
|  | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
|  | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6091h | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60C2h | — | Interpolation time period | — | — | — | — | — | ip<br>csp<br>csv<br>cst | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ip<br>csp<br>csv<br>cst | No | X |
| | 01h | Interpolation time period value | — | 0 to 255 | U8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| | 02h | Interpolation time index | — | -128 to 63 | I8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |
| | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

### 6.6.5.3.1.1 Controlword (6040h) (Functions in csp Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands for this product, such as PDS state transitions.

Bit data reference

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="6" rowspan="2">(1)</td><td>(2)</td><td rowspan="2">(3)</td><td rowspan="2">(4)</td><td colspan="3">(2)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td></tr>
<tr><td>(1)</td><td>(1)</td><td>(1)</td><td>(1)</td></tr>
</table>

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on

In csp mode, the operation mode specific bit is not used.

### 6.6.5.3.1.2 Position-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60B0h | 00h | Position offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | csp | Yes | A |

- Sets the offset for the position command.

### 6.6.5.3.1.3 Other

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | R |

- bit 5: Obj.6080h:00h “Max motor speed” enable or disable setting in csp (Command position change saturation function selection)
  0: Disabled
  1: Enabled

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |

- bit 11: Condition setting for Obj.6041h: bit 12 “drive follows command value”
  0: Includes torque limit and speed limit (cst only)
  1: Does not include torque limit and speed limit (cst only)

#### 6.6.5.3.2 Objects Related to csp Control Mode (Monitoring-related)

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | – | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

There are other related objects commonly used for position control. For details, see *"6.6.5.1 Position Control Common Functions"* .

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6065h | 00h | Following error window | Command unit | 0 to 4294967295 | U32 | rw | TxPDO | pp<br>csp | Yes | A |
| 6066h | 00h | Following error time out | ms | 0 to 65535 | U16 | rw | RxPDO | pp<br>csp | Yes | A |
| 6069h | 00h | Velocity sensor actual value | – | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN･m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

### 6.6.5.3.2.1 Statusword (6041h) (Functions in csp Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | (2) | | (3) | (2) | (4) | (1) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | | (13) | (14) | | (1) | | | | | | | | | | |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): following error
(14): drive follows command value

#### ■ Bit 13, 12, 10 (operation mode specific (control mode dependent bit)):

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | — | Not used |
| 12 | drive follows command value | 0 | Operation is not executed according to the target position (*1) |
| | | 1 | Operation is executed according to target position (*1) |
| 13 | following error | — | See *"6.6.5.1.2.5 Statusword (6041h) (Position Control Common Functions)"* . |

*1 An “operation has been executed according to the target position” means that all of the following conditions have been met.

- PDS status is Operation enabled
- Torque limit has not triggered (when Obj.3724h:00h “Communication function extended setup 3” :bit 11 = 0)
- When a positive direction operation command is in progress, the command or actual position does not exceed the Obj.607Dh:02h “Max position limit” setting value.
- When a negative direction operation command is in progress, the command or actual position does not exceed the Obj.607Dh:01h “Min position limit” setting value.

### 6.6.5.3.2.2 Other

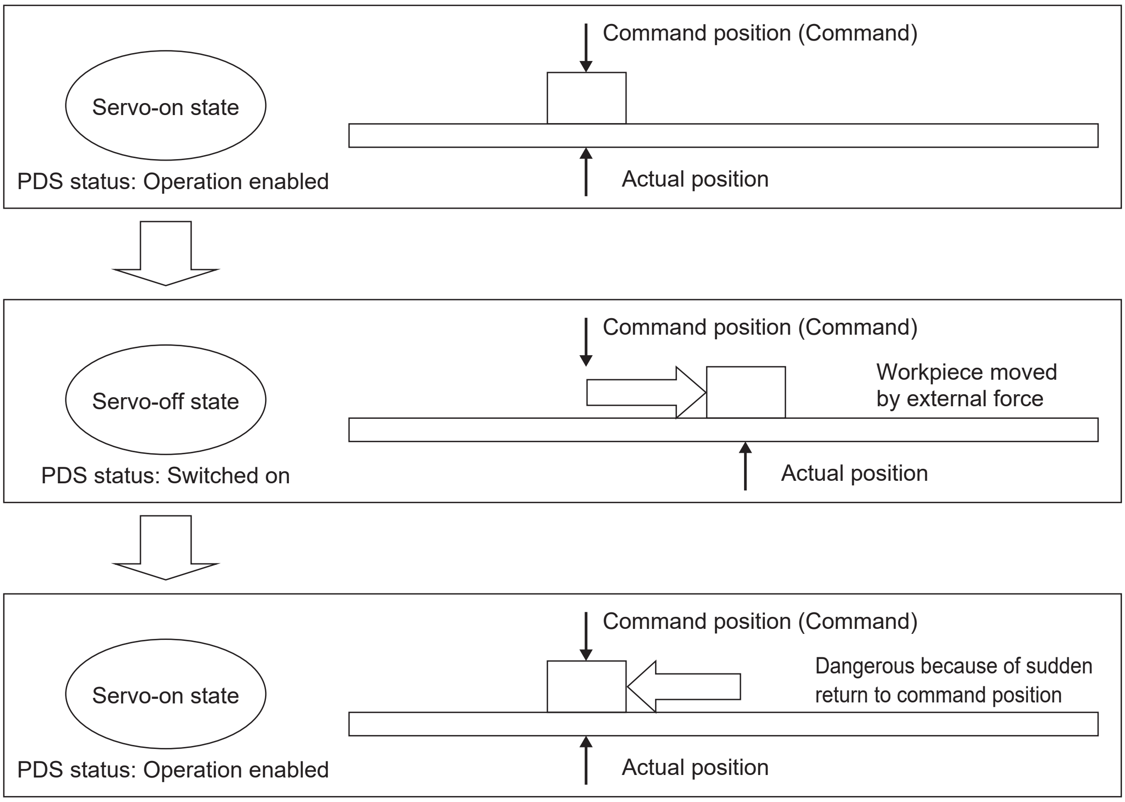
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| ● bit 11: Condition setting for Obj.6041h: bit 12 “drive follows command value”<br>0: Includes torque limit and speed limit (cst only)<br>1: Does not include torque limit and speed limit (cst only) | | | | | | | | | | |

### 6.6.5.3.3 Operation in csp Control Mode

- In cyclic position control mode, the motion profile (trajectory) is generated by the main device, not the sub device.
- The target position is the Obj.607Ah:00h “Target position” and the additional value of Obj.60B0h:00h “Position offset” and is interpreted as an absolute position.
- Input the operation command update (transmission) after approximately 100 ms have elapsed since servo-on command (operation enabled command).
- Obj.60C2h: “Interpolation time period” indicates a cycle of updating two objects, Obj.607Ah:00h “Target position” and Obj.60B0h:00h “Position offset” . This value is set to the same cycle as Obj.1C32h:02h “Cycle time” . The main device must always update the target position in cycle Obj.60C2h: “Interpolation time period” .
- In the servo-off state, configure the main device process so that Obj.607Ah:00h “Target position” + Obj.60B0h:00h “Position offset” follows Obj.6064h:00h “Position actual value” . If this is not performed, a dangerous situation can arise because the next time the servo is turned on, the motor will try to return to the input target position if it is moved by an external force during servo-off. Also, when switching from a different control mode to csp control mode, this process should be performed in the same way.

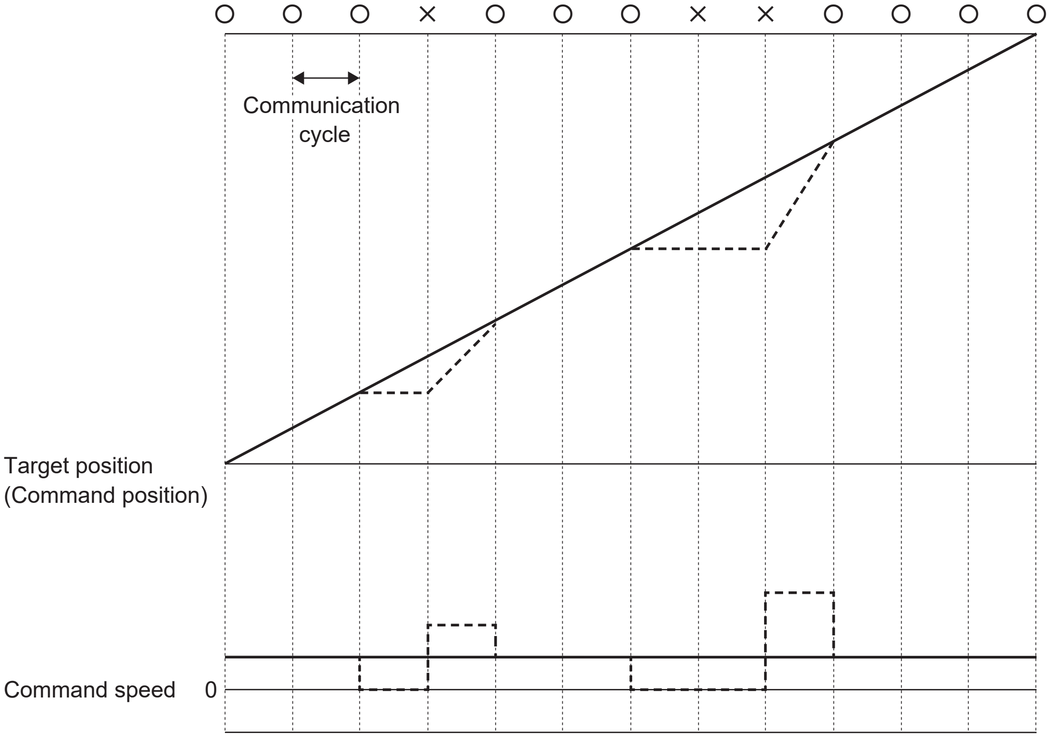
**Example of dangerous situation: Command position at servo-off (when the command position does not follow the actual position value)**



### 6.6.5.3.4 Correction Processing when Communication Errors Occur

If a communication error occurs during operation and Obj.607Ah:00h “Target position” cannot be loaded normally, the target position is estimated and correction processing is performed.

An example of the compensation process is shown in the figure below. In the communication cycle in which a communication error occurs (× in the figure), the target position is in the dashed line. In this case, processing is performed to compensate for the target position from the dashed line state to the solid line (estimated target position).



* Solid line: After processing command correction Dashed line: Before processing command correction

○: Communication normal ×: Communication error

#### 6.6.5.3.5 Command Position Change Saturation Function

The command position change saturation function saturates the command position change with a value converted from Obj.6080h:00h "Max motor speed" to prevent Err27.4.0 "Position command error protection" from occurring due to an abnormal command position and to stabilize motor operation.

##### ■ Applicable range

This function is supported only in the following control modes.

| | Conditions under which the command position saturation function operates |
|---|---|
| Control mode | ● Position control (csp) |

##### ■ Controlword (6040h) (Functions in csp Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | R |
| ● bit 5: Obj.6080h:00h "Max motor speed" enable or disable setting in csp (Command position change saturation function selection)<br>0: Disabled<br>1: Enabled | | | | | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes (*1) | B |
| ● Sets the maximum motor speed.<br>● The maximum value is limited to the maximum velocity output by the motor using internal processing. | | | | | | | | | | |

*1 The value stored in EEPROM is set when the control power is turned on.

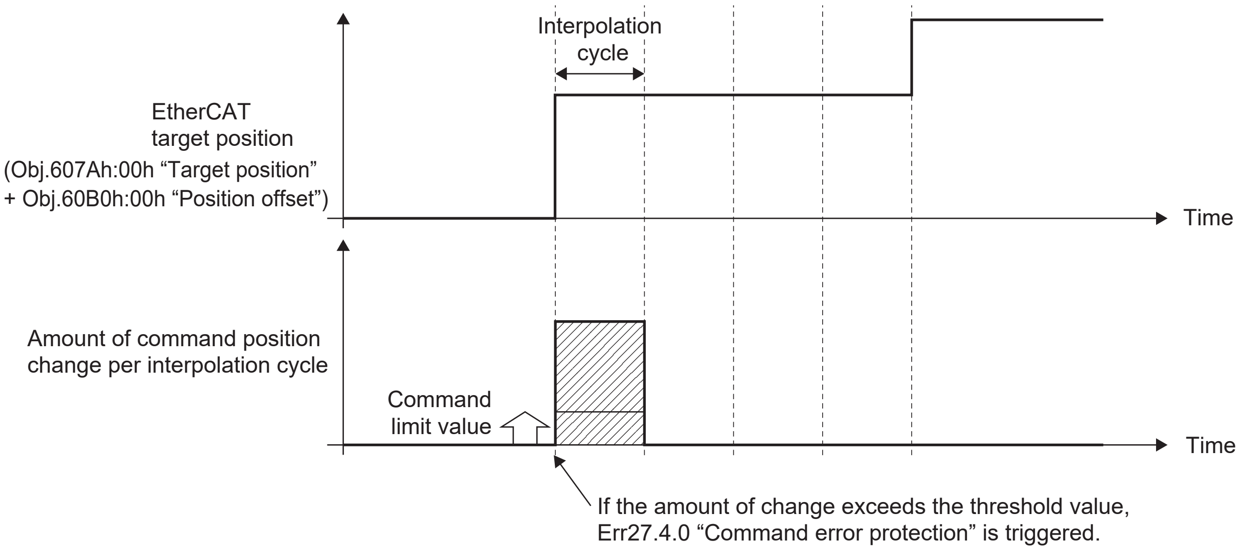
**— Precautions —**

- When this function is enabled (Obj.3722h:00h "Communication function extended setup 1" :bit 5 = 1), even if an abnormal command position is received, the command is divided and the occurrence of Err27.4.0 "Position command error protection" is inhibited.
- When this function is enabled (Obj.3722h:00h "Communication function extended setup 1" :bit 5 = 1) and Obj.6080h:00h "Max motor speed" = 0, the command position change is limited to 0 and the motor does not move. Also, Obj.6041h:00h "Statusword" :bit 11 "internal limit active" does not become 1.

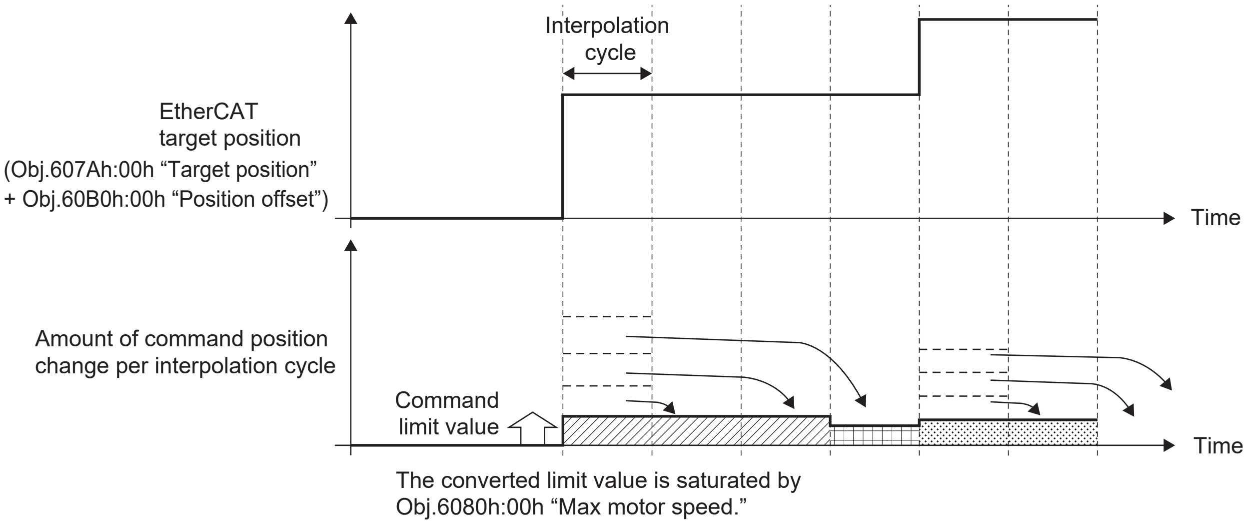
##### ■ Example of operation (Interpolation cycle=125 us)

If the amount of change in the target position (Obj.607Ah:00h "Target position" + Obj.60B0h:00h "Position offset" ) from the host device exceeds the command limit value (threshold value generated by Err27.4.0 "Position command error protection" ), the amount of change in command position per interpolation cycle is saturated with the limit value converted from Obj.6080h:00h "Max motor speed" . This prevents Err27.4.0 from occurring and stabilizes operation even when a host device sends an abnormal command position.

### When the command position change saturation function is disabled



### When the command position change saturation function is enabled



### 6.6.5.3.6 Displacement Control Function

The displacement control function takes an analog input voltage from an external sensor and converts the value as a position compensation value. Settings for adjusting the position compensation value, filter settings for noise filtering, and offset adjustment can be performed.

This function is enabled when Obj.3022h:00h "Sensor feedback control mode setup" = 1 (sensor feedback enabled) and Obj.4351h:00h "Analog input function" :bit 0 "Displacement control function switch" = 1 (displacement control enabled).

Some objects have different object numbers and have the same name and the same function. These objects use the same memory area for their settings. Therefore, if you make settings in one object and then make different settings in the other object, the later settings will be overwritten. For objects with the same name and same functionality under different object numbers, check *"6.6.5.3.6.1 Related Objects"* .

For a control block diagram of displacement control, see Technical Reference Functional Specification "5.7.1 Displacement Control Function" "Control Block Diagram".

#### 6.6.5.3.6.1 Related Objects

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3022h | 00h | Sensor feedback control mode setup | — | 0 to 1 | I16 | rw | No | csp | Yes | R |
| ● Selects the sensor feedback control mode for this product.<br>0: Sensor feedback disabled<br>1: Sensor feedback enabled (position feedback) | | | | | | | | | | |
| 4C00h | 00h | Number of entries | — | 7 | U8 | ro | No | csp | No | B |
| ● Displays the number of sub-indexes in Obj.4C00h: "Analog servo parameters" . | | | | | | | | | | |
| 3333h | 00h | Analog input gain | Command unit/mV | 0 to 30000 | I16 | rw | No | csp | Yes | B |
| 4C00h | 01h | | | | | | | | | |
| ● Converts the voltage applied to the analog input to a position compensation value in command units. | | | | | | | | | | |
| 3334h | 00h | Analog input polarity | — | 0 to 1 | I16 | rw | No | csp | Yes | B |
| 4C00h | 02h | | | | | | | | | |
| ● Selects the specification method for the positive direction and negative direction of displacement control.<br>0: Not reversed<br>1: Reversed | | | | | | | | | | |
| 3335h | 00h | Analog input integration time constant | 0.01 ms | 0 to 100000 | I32 | rw | No | csp | Yes | B |
| 4C00h | 03h | | | | | | | | | |
| ● Sets the integral time constant of the voltage applied to the analog input.<br>When this setup value is 0 or 100000, the integral time constant setting is disabled. | | | | | | | | | | |
| 3336h | 00h | Analog input integration limit | Command unit | 0 to 2147483647 | I32 | rw | No | csp | Yes | B |
| 4C00h | 04h | | | | | | | | | |
| ● Sets the limit for the integral term of the voltage applied to the analog input in absolute value. | | | | | | | | | | |
| 3422h | 00h | Analog input (AIN) offset setting | 0.375 mV | -26666 to 26666 | I16 | rw | No | ALL | Yes | B |
| 4C00h | 05h | | | | | | | | | |
| ● Sets the offset adjustment value for the voltage applied to the analog input. | | | | | | | | | | |
| 3423h | 00h | Analog input (AIN) filter setting | 0.01 ms | 0 to 6400 | I16 | rw | No | ALL | Yes | B |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4C00h | 06h | Analog input (AIN) filter setting | 0.01 ms | 0 to 6400 | I16 | rw | No | ALL | Yes | B |
| | | ● Sets the time constant of the first order lag filter relative to the voltage applied to the analog input.<br>Disabled when the set value is 0 to 3. | | | | | | | | |
| 3424h | 00h | Analog input (AIN) excessive setting | 0.1 V | 0 to 100 | I16 | rw | No | ALL | Yes | B |
| 4C00h | 07h | | | | | | | | | |
| | | ● Sets the excessive level for the applied voltage (after offset addition) of the analog input. If the absolute value of the applied voltage exceeds the setup value, Err39.0.0 “Analog input (AIN) excess protection” is triggered. | | | | | | | | |
| 4314h | 00h | Analog input internal offset | mV | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| | | ● Sets the offset tuningvalue for the voltage applied to the analog input.<br>Set within the range of -10000 to 10000. | | | | | | | | |
| 4315h | 00h | Analog input deviation limit | mV | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| | | ● Sets the limit value for analog voltage deviation as an absolute value. Disabled when set value is 0.<br>Set within the range of 0 to 10000. If set beyond 10000, 10000 is set internally. | | | | | | | | |
| 4316h | — | Analog input voltage setup | — | — | — | — | — | — | — | — |
| | | ● Configures settings related to analog input voltage. | | | | | | | | |
| 4316h | 00h | Number of entries | — | 1 | U8 | ro | No | ALL | No | X |
| | | ● Displays the number of sub-indexes in Obj.4316h: “Analog input voltage setup” . | | | | | | | | |
| 4316h | 01h | Analog input voltage dead zone | mV | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | B |
| | | ● Sets the dead zone for the analog input voltage.<br>When the displacement control function is enabled (Obj.3022h:00h “Sensor feedback control mode setup” = 1 and Obj.4351h:00h “Analog input function” :bit 0 = 1), the dead zone function of the analog input voltage is enabled.<br>Even if the displacement control function is enabled, if this setting value is 0, the dead zone function of the analog input voltage is disabled.<br>For details on the function, see *“Dead zone function for analog input voltage”* below. | | | | | | | | |
| 4351h | 00h | Analog input function | — | 0 to 65535 | U16 | rw | RxPDO | csp | Yes | B |
| | | ● Set the functions in bit units.<br>bit 0: Displacement control function switch<br>0: Displacement control disabled<br>1: Displacement control enabled<br>When Obj.3022h:00h “Sensor feedback control mode setup” = 1, function switching is enabled.<br>bit 1: Position command latch switch<br>0: Latch enabled<br>1: Latch disabled<br>If bit 0 is changed from 0 (disable displacement control) to 1 (enable displacement control) when bit 1 is 1 (latch disabled), the command position (Obj.607Ah:00h “Target position” + Obj.60B0h:00h “Position offset” ) is not latched. | | | | | | | | |
| 4D51h | 00h | Analog input status | — | 0 to 65535 | U16 | ro | TxPDO | csp | No | X |
| | | ● Displays the setting status with Obj.4351h:00h “Analog input function”<br>Bit 0: Setting status of displacement control function switch<br>0: Displacement control disabled<br>1: Displacement control enabled<br>Bit 1: Setting status of position command latch switch<br>0: Latch enabled<br>1: Latch disabled | | | | | | | | |
| 4F03h | 00h | Analog input internal voltage | mV | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| | ● Displays the level of the applied voltage (after offset and filter) of the analog input. | | | | | | | | | |
| 4F4Fh | 00h | Analog input value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | csp | No | X |
| | ● Displays the position compensation value according to the voltage applied to the analog input. | | | | | | | | | |
| 4FC2h | 00h | Analog input voltage | mV | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the level of the applied voltage (before offset) of the analog input. | | | | | | | | | |

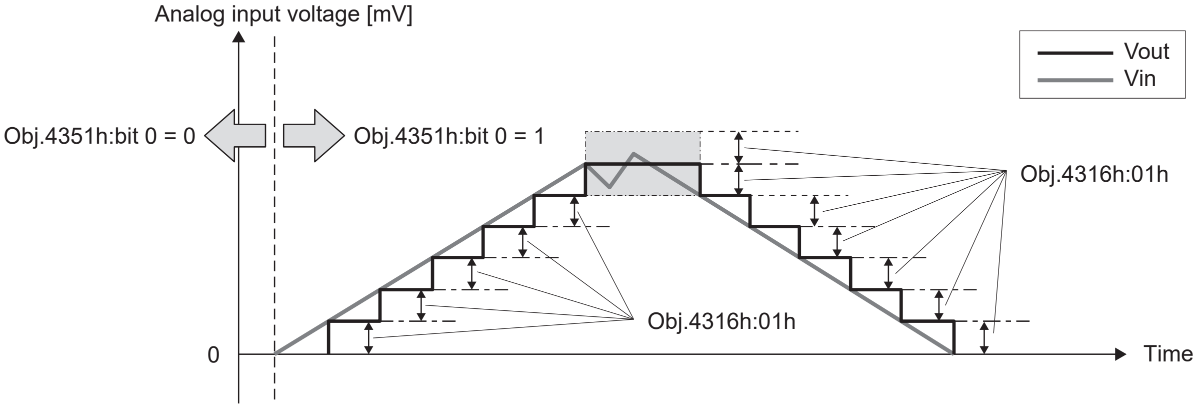
## ■ Dead zone function for analog input voltage

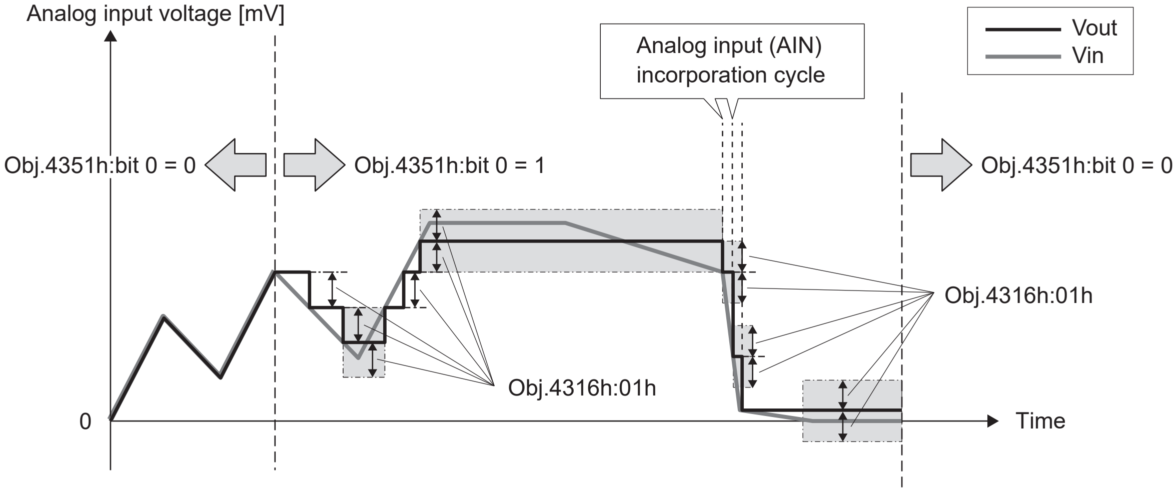
For the operation when the dead zone function of analog input voltage is enabled, see Technical Reference Functional Specification “5.7.1 Displacement Control Function” “Control Block Diagram”.

Vin in the control block diagram is the analog input voltage before the analog input voltage dead zone function processing. The value of Vin can be checked with Obj.4FC2h:00h “Analog input voltage” .

Vout is the analog input voltage after the dead zone function processing of the analog input voltage. Vout holds the original Vout value without reflecting the change in Vin until the change in Vin exceeds Obj.4316h:01h “Analog input voltage dead zone” .

If the change in Vin exceeds Obj.4316h:01h “Analog input voltage dead zone” , Vout reflects the change in Vin and the value of Vout = Vin.





#### 6.6.5.3.6.2 Procedure for Adjusting the Auto-focus Control Function

1 Setting the motor gain

Gain adjustment of the position control system is performed by real-time auto tuning or manual tuning.

2 Displacement control function operation setting

Adjust the displacement control function with Obj.3336h:00h “Analog input integration limit” and Obj.3422h:00h “Analog input (AIN) offset setting” .

- Obj.3336h:00h “Analog input integration limit” setting

  The analog input integration limit is a value that limits the command required for motor operation to ensure a gap. The limit value is set with a margin to the command required for motor operation to ensure a gap.

  Calculate according to the following formula.

  3336h = (1.2 (*1)) × command required for motor operation to ensure a gap [command units]

  For example, if one motor revolution = 10000 command units (*2) and the pitch of the ball screw = 5 mm, a workpiece variation of 30 mm would result in 60000 command units, so the margin is set at 60000.

  3336h = (1.2) × 60000 = 72000

  *1 Margin considering overshoot

  *2 The command required for one motor revolution should be calculated from the electronic gear, encoder resolution, and number of pulses per motor revolution.

- Obj.3422h:00h “Analog input (AIN) offset setting” setting

  The analog input offset refers to the analog output voltage of the target gap.

  Calculate according to the following formula.

  3422h = Analog output voltage of target gap [mV] × 26666/10000

  For example, an analog output voltage of 2500 mV at the target distance to be held from the workpiece would be as follows.

  3422h = 2500 × 26666/10000 = 6667

3 Displacement control function switch selection setting

To enable the displacement control function, set Obj.4351h:00h “Analog input function” :bit 0 = 1 to enable the displacement control function.

Before operating the displacement control function, move the displacement sensor to the area of the target distance to be held from the workpiece.

**— Precautions —**

- If the displacement control function is activated while the displacement sensor is not near the target distance, the motor rotates at a high speed to approach the target distance, creating a hazard.

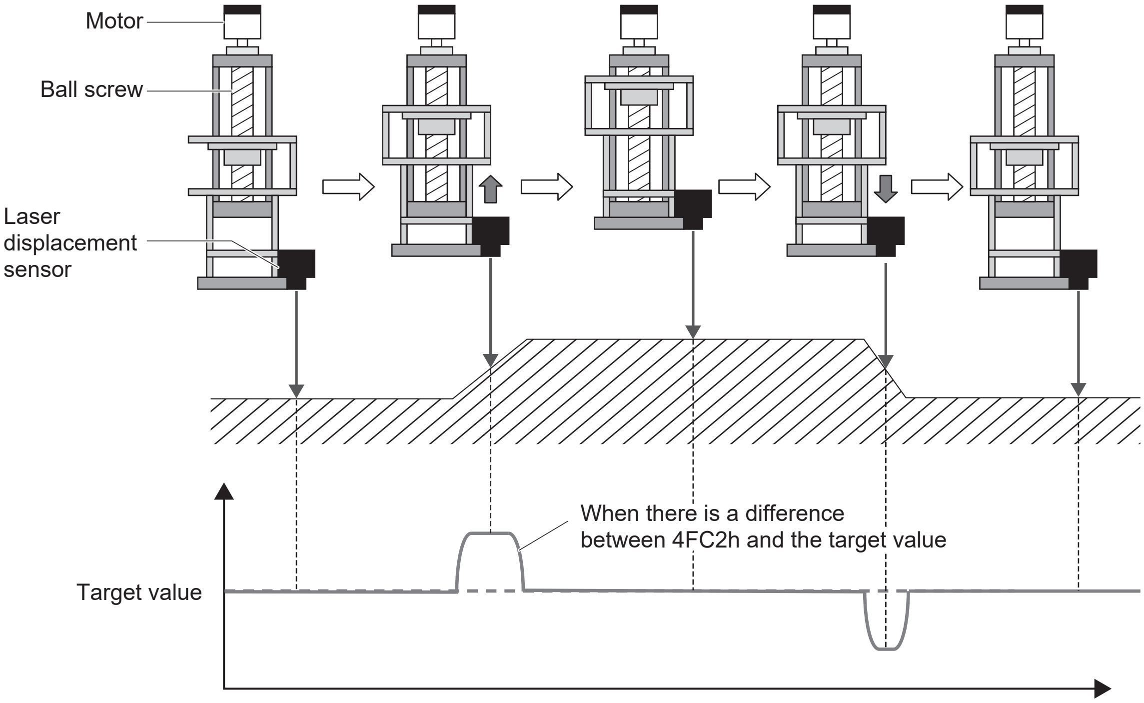
4 Adjustment of displacement control

Adjust the displacement control while checking the analog input voltage with Set-up Support Software (PANATERM ver.7) .

Tune Obj.3333h:00h “Analog input gain” and Obj.3335h:00h “Analog input integration time constant” so that the measurement distance of the displacement sensor is constant regardless of the workpiece position.

Gradually set Obj.3333h:00h “Analog input gain” slightly larger or Obj.3335h:00h “Analog input integration time constant” slightly smaller so that the difference between Obj.4FC2h:00h “Analog input voltage” and the target value becomes smaller.

If the difference from the target value is reduced beyond the limit in the above settings, the product may vibrate.



### 6.6.5.3.6.3 Precautions

- In the following cases, Obj.4F4Fh:00h "Analog input value" is cleared to 0.
  - When Obj.4351h:00h "Analog input function" :bit 0 = 0 (displacement control disabled)
  - When not in csp control mode
  - During servo-off
- When the displacement control function switch is changed from enabled to disabled (Obj.4351h:00h "Analog input function" :bit 0 = 1 to 0), the motor may suddenly operate.

  To prevent sudden operation, switch the displacement control function to disabled with the value of Obj.607Ah:00h "Target position" +Obj.60B0h:00h "Position offset" matching the value of Obj.6062h:00h "Position demand value" from the host device.
- If vibration or abnormal noise occurs during displacement control function operation, take the following measures.
  - Make Obj.3333h:00h "Analog input gain" smaller or Obj.3335h:00h "Analog input integration time constant" larger.
  - Adjust the gain and filter of the position control system.
  - Match Obj.3223h:00h "Positional command FIR filter" with the EtherCAT communication cycle.
  - Make Obj.3423h:00h "Analog input (AIN) filter setting" larger.
  - Adjust the filter and responsiveness on the displacement sensor side.
- If abnormal noise occurs while the motor position is stable, take the following measures.
  - Set Obj.4316h:01h "Analog input voltage dead zone" .
  - Make Obj.3608h:00h "Positive direction torque compensation value" and Obj.3609h:00h "Negative direction torque compensation value" smaller.
- If the displacement sensor fails to measure the distance and an unexpected voltage is applied to the analog input, the motor may malfunction or operate in a dangerous way.

  The displacement sensor should be installed so that it can always measure the distance even if the difference in the height of the workpiece changes.

In addition, set the voltage deviation limit at Obj.4315h:00h “Analog input deviation limit” to prevent unexpected operation due to excessive voltage deviation.

#### 6.6.5.4 Interpolated Position Control Mode (ip) (Not Supported)

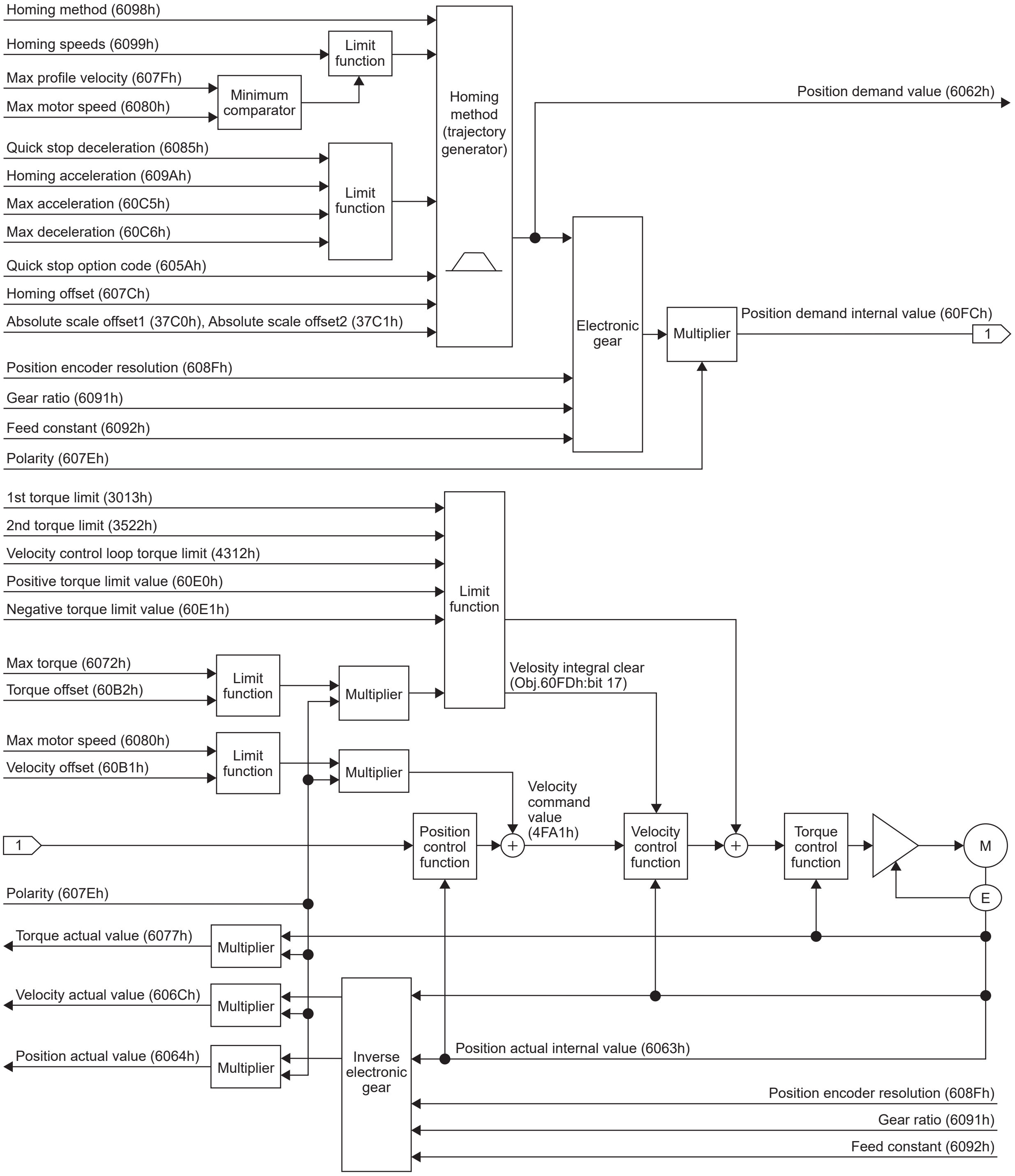
Interpolated position control mode (ip) is not supported in this software version.

Do not set Obj.6060h:00h “Modes of operation” to 7.

This is a position control mode in which the host device generates position commands, buffers them within the product in the communication cycle, and operates by updating the buffered command position in the interpolation time.

### 6.6.5.5 Homing Position Control Mode (hm mode)

Homing position control (hm mode): A control mode in which the host device designates the homing method and operating velocity, generates position commands inside the servo driver, and performs the homing operation.



## ■ Incremental mode

After the control power is turned on, a homing operation must be performed before positioning operation.

## ■ Absolute mode

By performing the homing operation, the driver can automatically set the values of Obj.37C0h:00h “Absolute scale offset1” and Obj.37C1h:00h “Absolute scale offset2” and save them in the EEPROM.

After the homing operation is completed, the value of the sum of pulses of monitor Set-up Support Software (PANATERM ver.7) reflects the values of Obj.37C0h:00h “Absolute scale offset1” and Obj.37C1h:00h “Absolute scale offset2” and becomes 0, but the position information of the encoder and external scale remains unchanged.

Since the values of Obj.37C0h:00h “Absolute scale offset1” and Obj.37C1h:00h “Absolute scale offset2” are stored in EEPROM, there is no need to perform a homing operation each time the control power is turned on.

### 6.6.5.5.1 Objects Related to hm Control Mode (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3780h | — | Communication function extended setup 8 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| 37C0h | — | Absolute scale offset1 | Rotation (multi-turn data), or pulse (upper 32 bits of external scale) | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | R |
| 37C1h | — | Absolute scale offset2 | Pulse (single-turn data) or pulse (lower 32 bits of external scale) | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | R |
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6098h | 00h | Homing method | — | -128 to 127 | I8 | rw | RxPDO | hm | No | B |
| 6099h | — | Homing speeds | — | — | — | — | — | hm | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | hm | No | X |
| | 01h | Speed during search for switch | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| | 02h | Speed during search for zero | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |

There are other related objects commonly used for position control. For details, see *“6.6.5.1 Position Control Common Functions”* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes | B |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60C5h | 00h | Max acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 60C6h | 00h | Max deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | — | Position range limit | — | — | — | — | — | ALL | — | — |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
|  | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |
| 6085h | 00h | Quick stop deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |
| | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

### 6.6.5.5.1.1 Absolute scale offset1 (37C0h)

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 37C0h | 00h | Absolute scale offset1 | Rotation (multi-turn data), or pulse (upper 32 bits of external scale) | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | R |

- When the homing operation is performed in absolute mode, the driver automatically sets the difference (offset value) between the encoder 0 position (or external scale 0 position) and the home detection position so that Obj.6063h:00h “Position actual internal value” becomes 0 at that position after the home position is detected. After setting, only this object is automatically saved in EEPROM.
- Equivalent to the upper 32 bits of 64-bit (consisting of upper 24 bits + lower 24 bits data) encoder multi-turn data or external scale data.
- Do not change this object manually, as changing the value of this object will change the home position.

**Notes**

- To return the home position to the initial state, manually set this object to 0 and write the value to EEPROM.

  Change both Obj.37C0h:00h “Absolute scale offset1” and Obj.37C1h:00h “Absolute scale offset2” to 0. Operation is not guaranteed if a value other than 0 is manually set. The manually set value is enabled by reconnecting the control power supply.

- In incremental mode (Obj.3015h:00h “Absolute encoder setup” = 1), this object is disabled.

### 6.6.5.5.1.2 Absolute scale offset2 (37C1h)

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 37C1h | 00h | Absolute scale offset2 | Pulse (single-turn data) or pulse (lower 32 bits of external scale) | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | R |

- When the homing operation is performed in absolute mode, the driver automatically sets the difference (offset value) between the encoder 0 position (or external scale 0 position) and the home detection position so that Obj.6063h:00h “Position actual internal value” becomes 0 at that position after the home position is detected. After setting, only this object is automatically saved in EEPROM.
- Equivalent to the lower 32 bits of 64-bit (consisting of upper 24 bits + lower 24 bits data) encoder single-turn data or external scale data.
- Do not change this object manually, as changing the value of this object will change the home position.

**Notes**

- To return the home position to the initial state, manually set this object to 0 and write the value to EEPROM.

  Change both Obj.37C0h:00h “Absolute scale offset1” and Obj.37C1h:00h “Absolute scale offset2” to 0. Operation is not guaranteed if a value other than 0 is manually set. The manually set value is enabled by reconnecting the control power supply.

- In incremental mode (Obj.3015h:00h “Absolute encoder setup” = 1), this object is disabled.

### 6.6.5.5.1.3 Controlword (6040h) (Functions in hm Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands for this product, such as PDS state transitions.

Bit data reference

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="6" rowspan="2">(1)</td><td>(2)</td><td rowspan="2">(3)</td><td rowspan="2">(4)</td><td colspan="3">(2)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td></tr>
<tr><td>(1)</td><td>(1)</td><td>(1)</td><td>(9)</td></tr>
</table>

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on
(9): start homing

**■ bit 9, 6 to 4 (operation mode specific):**

—: N/A

| bit | Name | Value | Definition |
|---|---|---|---|
| 4 | start homing | 0 to 1 | Starts homing operation. (*1) |
| 5 | (reserved) | — | Not used |
| 6 | (reserved) | — | Not used |
| 9 | (reserved) | — | Not used |

*1 When Obj.3698h:00h “Function expansion setup 4” :bit 8 = 1 is set, homing operation starts even if the control mode is switched from Obj.6060h:00h “Modes of operation” = 8 (csp) to 6 (hm) with Obj.6040h:00h “Controlword” :bit 4 = 1.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3698h | 00h | Function expansion setup 4 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | R |

- bit 8: Control mode switch function expansion
  0: Conventional specification
  1: hm operation expanded specification

At the rising edge of Obj.6040h:00h “Controlword” :bit 4 “start homing” , the homing position control mode (hm) related parameters (homing method, speed, acceleration/deceleration, etc.) are taken in and operation starts.

Note that if a new homing operation is started during the homing operation (Obj.6040h:00h “Controlword” :bit 4 starts up again), the new homing operation is ignored.

### 6.6.5.5.1.4 Homing method (6098h)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6098h | 00h | Homing method | — | -128 to 127 | I8 | rw | RxPDO | hm | Yes | B |

- Sets the homing method.

| Value | Definition |
|---|---|
| 0 | No homing method assigned |
| 1 | -Ve LS & Index Pulse |
| 2 | +Ve LS & Index Pulse |
| 3 | +Ve HS & Index Pulse direction reversal |
| 4 | +Ve HS & Index Pulse no direction change |
| 5 | -Ve HS & Index Pulse direction reversal |
| 6 | -Ve HS & Index Pulse no direction change |
| 7 | on +Ve HS -Index Pulse |
| 8 | on +Ve HS +Index Pulse |
| 9 | After +ve HS reverse +Index Pulse |
| 10 | After +ve HS +Index Pulse |
| 11 | on -Ve HS -Index Pulse |
| 12 | on -Ve HS +Index Pulse |
| 13 | After -ve HS reverse +Index Pulse |
| 14 | After -ve HS +Index Pulse |
| 15 | Reserved |
| 16 | Reserved |
| 17 | Same as 1 without Index Pulse |
| 18 | Same as 2 without Index Pulse |
| 19 | Same as 3 without Index Pulse |

| Value | Definition |
|---|---|
| 20 | Same as 4 without Index Pulse |
| 21 | Same as 5 without Index Pulse |
| 22 | Same as 6 without Index Pulse |
| 23 | Same as 7 without Index Pulse |
| 24 | Same as 8 without Index Pulse |
| 25 | Same as 9 without Index Pulse |
| 26 | Same as 10 without Index Pulse |
| 27 | Same as 11 without Index Pulse |
| 28 | Same as 12 without Index Pulse |
| 29 | Same as 13 without Index Pulse |
| 30 | Same as 14 without Index Pulse |
| 33 | On Index Pulse +Ve direction |
| 34 | On Index Pulse -Ve direction |
| 35 | Current position = home |
| 37 | Current position = home |

+Ve: positive direction
-Ve: negative direction
LS: Limit switch
HS: Home switch

**— Precautions —**

- If Homing Operation Start is set to a setup value other than the one supported by Obj.6098h:00h “Homing method” , the Homing error (Obj.6041h:00h “Statusword” :bit 13) is set to 1. The homing method cannot be switched while the homing position control mode (hm) is running. Switch methods when the motor is stopped (hm not running).

### 6.6.5.5.1.5 Homing speeds (6099h)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6099h | 00h | Number of entries | — | 2 | U8 | ro | No | hm | No | X |

- Displays the number of sub-indexes in Obj.6099h: “Homing speeds” .

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>6099h</td><td>01h</td><td>Speed during search for switch</td><td>Command unit/s</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>hm</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the operation speed until the switch signal is detected.<br>● The maximum value is limited by an internal process to the smallest of Obj.607Fh:00h “Max profile velocity” , Obj.6080h:00h “Max motor speed” , and 2147483647.</td></tr>
<tr><td>6099h</td><td>02h</td><td>Speed during search for zero</td><td>Command unit/s</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>hm</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the operation speed to the home detection position.<br>When using the edge of the switch signal as the home detection position, set this value as small as possible to reduce the detection error.<br>● The maximum value is limited by an internal process to the smallest of Obj.607Fh:00h “Max profile velocity” , Obj.6080h:00h “Max motor speed” , and 2147483647.</td></tr>
</table>

For more information on the application of each speed, please see the operating examples of each Homing method ( *“6.6.5.5.3 hm Control Mode Operation (Homing Operation)”* ).

### 6.6.5.5.1.6 Homing acceleration (609Ah)

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>609Ah</td><td>00h</td><td>Homing acceleration</td><td>Command unit/s$^2$</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>hm</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets acceleration and deceleration in homing position control mode (hm).<br>● The deceleration in homing position control mode (hm) is also used by this object.<br>● At the final stop of each homing method (when the home position is detected), this object’s setup value is not used and the servo lock stops.<br>● If set to 0, treated as 1 by internal processing.</td></tr>
</table>

#### 6.6.5.5.2 Objects Related to hm Control Mode (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60E3h | — | Supported homing methods | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 1 to 32 | U8 | ro | No | ALL | No | X |
| | 01h | 1st supported homing method | — | -128 to 127 | I8 | ro | No | ALL | No | X |
| | ⋮ | | | | | | | | | |
| | 20h | 32nd supported homing method | — | -128 to 127 | I8 | ro | No | ALL | No | X |

There are other related objects commonly used for position control. For details, see *“6.6.5.1 Position Control Common Functions”* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN・m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 60F4h | 00h | Following error actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 60FAh | 00h | Control effort | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |

There are other related objects commonly used for motion. For details, see *“6.6.8 Motion Common Functions”* .

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | – | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | – | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FDh | 00h | Digital inputs | – | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

#### 6.6.5.5.2.1 Statusword (6041h) (Functions in hm Control Mode)

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | – | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

Bit data reference

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2">(1)</td><td colspan="2">(2)</td><td rowspan="2">(3)</td><td>(2)</td><td rowspan="2">(4)</td><td rowspan="2">(1)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td><td rowspan="2">(9)</td><td rowspan="2">(10)</td><td rowspan="2">(11)</td><td rowspan="2">(12)</td></tr>
<tr><td>(13)</td><td>(14)</td><td>(15)</td></tr>
</table>

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): homing error
(14): homing attained
(15): target reached

### ■ Bit 13, 12, 10 (operation mode specific (control mode dependent bit)):

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | In operation |
| | | 1 | Stopped |
| 12 | homing attained | 0 | Homing operation not completed (*1) |
| | | 1 | Homing operation has been successfully executed and completed (*2) |

| bit | Name | Value | Definition |
|---|---|---|---|
| 13 | homing error | 0 | No homing error occurred (Normal) |
| | | 1 | Homing error occurred<br>(Homing operation was not executed properly) |

Combinations of bit 13, bit 12, and bit 10 values are shown in the table below.

| bit 13 | bit 12 (*2) | bit 10 | Definition |
|---|---|---|---|
| 0 | 0 | 0 | Homing in operation |
| 0 | 0 | 1 | Homing operation interrupted or not started |
| 0 | 1 | 0 | Homing operation is completed, but target position has not been reached |
| 0 | 1 | 1 | Homing operation completed successfully |
| 1 | 0 | 0 | Homing error detected but still in operation |
| 1 | 0 | 1 | Homing error detected and stopped |

*1 In increment mode, bit 12 “homing attained” is set to 0 when the following is true.

- When control power is turned on
- When the ESM state changes from Init to PreOP
- When homing operation starts

  When the homing operation (Method 35, Method 37) without motor operation is activated, homing attained is 0. However, the time to zero is short (approximately 2 ms).
- Operation in Set-up Support Software (PANATERM ver.7) (trial run, frequency characteristics analysis function (FFT function), One Minute TUNING, Z-phase search, Config execution) at completion (Obj.3799h:00h “Communication function extended setup 6” :bit 0 is set to 1)
- When Err27.4.0 “Position command error protection” occurs

*2 In absolute mode, bit 12 “homing attained” is set to 1 when power is activated, but is set to 0 under the following.

- When homing operation starts
- When homing operation ends abnormally
- When the multi-turn data clear is executed in hm control mode, bit 12 “homing attained” is set to 0 once.

  After completion of the multi-turn data clear, bit 12 “homing attained” returns to 1.
- When Set-up Support Software (PANATERM ver.7) (trial run, frequency characteristics analysis function (FFT function), One Minute TUNING, Z-phase search, Config execution) finishes during homing command startup (Obj.3799h:00h “Communication function extended setup 6” :bit 0 is 1)

### 6.6.5.5.2.2 Supported homing methods (60E3h)

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E3h | – | Supported homing methods | – | – | – | – | – | – | – | – |
| | ● Displays supported homing methods. | | | | | | | | | |
| 60E3h | 00h | Number of entries | – | 32 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of homing methods supported by Obj.60E3h: “Supported homing methods” . | | | | | | | | | |
| 60E3h | 01h | 1st supported homing method | – | -128 to 127 | I8 | ro | No | ALL | No | X |
| | ● Displays the first homing method supported. | | | | | | | | | |
| | ⋮ | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E3h | 20h | 32nd supported homing method | — | -128 to 127 | I8 | ro | No | ALL | No | X |
| | ● Displays the 32nd homing method supported. | | | | | | | | | |

| Index | Sub-Index | bits 15 to 8 | bits 7 to 0 |
|---|---|---|---|
| | | Reserved | Supported Homing method (*1) |
| 60E3h | 01h | 0 | 1 |
| | 02h | 0 | 2 |
| | 03h | 0 | 3 |
| | 04h | 0 | 4 |
| | 05h | 0 | 5 |
| | 06h | 0 | 6 |
| | 07h | 0 | 7 |
| | 08h | 0 | 8 |
| | 09h | 0 | 9 |
| | 0Ah | 0 | 10 |
| | 0Bh | 0 | 11 |
| | 0Ch | 0 | 12 |
| | 0Dh | 0 | 13 |
| | 0Eh | 0 | 14 |
| | 0Fh | 0 | 17 |
| | 10h | 0 | 18 |
| | 11h | 0 | 19 |
| | 12h | 0 | 20 |
| | 13h | 0 | 21 |
| | 14h | 0 | 22 |
| | 15h | 0 | 23 |
| | 16h | 0 | 24 |
| | 17h | 0 | 25 |
| | 18h | 0 | 26 |
| | 19h | 0 | 27 |
| | 1Ah | 0 | 28 |
| | 1Bh | 0 | 29 |
| | 1Ch | 0 | 30 |
| | 1Dh | 0 | 33 |
| | 1Eh | 0 | 34 |
| | 1Fh | 0 | 35 |
| | 20h | 0 | 37 |

*1 For the relationship between the value and the homing method, see *“6.6.5.5.1.4 Homing method (6098h)”* in *“6.6.5.5.1 Objects Related to hm Control Mode (Command/Setting-related)”* .

Homing supports the setting values in the table below. If Homing Operation Start is performed with unsupported setup values, homing error (Obj.6041h:00h “Statusword” :bit 13) will be set to 1.

Homing support list

○: Supported ×: Not supported

| Obj.3001h:00h “Control mode setup” | Obj.3015h:00h “Absolute encoder setup” | Homing |
|---|---|---|
| 0: Semi-closed control | 0: Absolute mode | ○ |
| | 1: Incremental mode | ○ |
| | 2: Absolute mode (multi-turn counter over ignored) | ○ |
| | 3: Absolute mode (single-turn absolute mode) | ○ |
| | 4: Absolute mode (continuous rotating absolute encoder mode) | ○ |
| 6: Full-closed control | Obj.3323h:00h “External scale selection” | Homing |
| | 0: A/B-phase output type | ○ |
| | 1: Serial communication type (incremental) | ○ |
| | 2: Serial communication type (absolute) | ○ |

### 6.6.5.5.3 hm Control Mode Operation (Homing Operation)

When using in incremental mode, perform a Homing operation because the position information must be initialized before starting normal operation.

When used in absolute mode, homing operation is not required, but by performing the homing operation, the driver can automatically set the values of Obj.37C0h:00h “Absolute scale offset1” and Obj.37C1h:00h “Absolute scale offset2” and save them in the EEPROM.

After the home position is detected, the following objects are initialized (preset) based on that position.

Obj.6062h:00h “Position demand value” = Obj.6064h:00h “Position actual value” = Obj.607Ch:00h “Home offset”

Obj.6063h:00h “Position actual internal value” = Obj.60FCh:00h “Position demand internal value” = 0

When homing is performed, the position information is initialized (preset). Therefore, data acquired based on old location information (e.g., Touch probe position, etc.) must be reacquired.

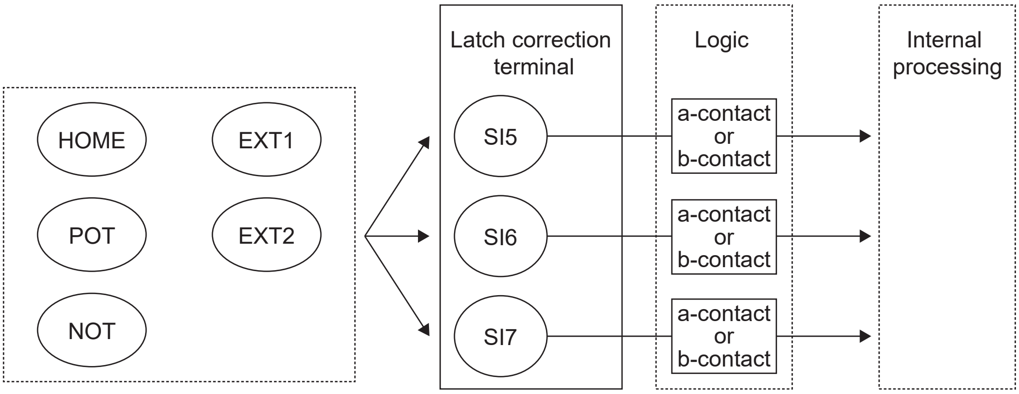
If Obj.607Ch:00h “Home offset” is changed during a Homing operation, it will not be reflected in the running Homing operation.

It will be applied to the next Homing operation (initialization of location information upon completion).

If the edge of the Switch signal (HOME, POT, NOT) is used as the home detection position, it can be freely assigned to the latch correction terminals SI5, SI6, and SI7. If it is not assigned correctly, a Homing error will result.

During homing operation, the Obj.3504h:00h “Over-travel inhibit input setup” setting is temporarily disabled.

- Connection when the sensor signal edge is home or latched

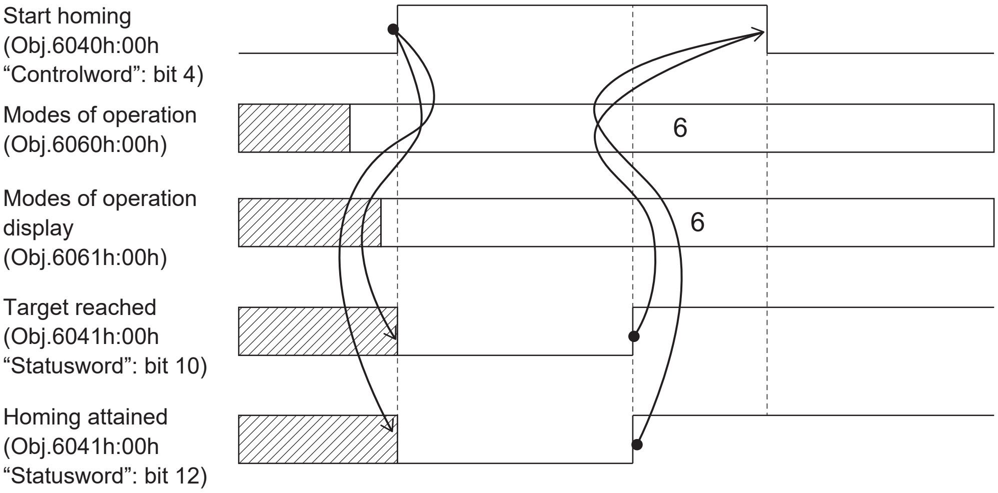


Description of terms shown in each Method diagram

| | |
|---|---|
| Index pulse | Z-phase signal of the encoder (external scale for full-closed control) |
| Home switch | Logic signal state of proximity to home input (HOME) |
| Positive limit | Logic signal state of positive direction over-travel inhibit input (POT) |
| Negative limit | Logic signal state of negative direction over-travel inhibit input (NOT) |

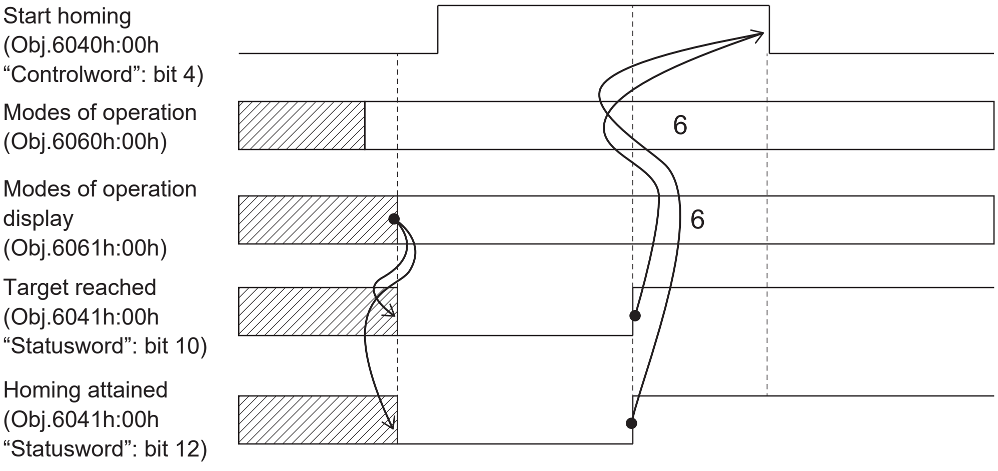
Input the operation command update (transmission) after approximately 100 ms have elapsed since servo-on command (operation enabled command).

- Sequence of hm control mode
  - **Obj.3780h:00h “Communication function extended setup 8” :bit 6 = 0**



Homing is not complete when Obj.6040h:00h “Controlword” :bit 4 is set to 1.

  - **Obj.3780h:00h “Communication function extended setup 8” :bit 6 = 1**



With this setting, homing is not completed when the control mode is switched to the homing position control mode. When performing consecutive homing operations, perform control mode switching before executing homing in order to make the homing operation incomplete again.

For homing operation using index pulse, it is recommended to set Obj.3722h:00h “Communication function extended setup 1” :bit 7 “Over-travel inhibit input detection setting during Z-phase homing return operation” to 1.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | B |
| ● bit 7: Over-travel inhibit input detection setting during Z-phase homing return operation<br>0: Disabled<br>1: Enabled | | | | | | | | | | |
| 3780h | 00h | Communication function extended setup 8 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| ● bit 6: Obj.6041h:00h “Statusword” : bit 12 Expansion setup for “homing attained”<br>0: Set when homing operation starts<br>1: Set during mode of homing position control switching | | | | | | | | | | |

By setting Obj.3722h:00h “Communication function extended setup 1” :bit 7 “Over-travel inhibit input detection setting during Z-phase homing return operation” to 1, protection can be provided by triggering Err94.3.0 “Homing error protection 2” when the amount of movement becomes abnormal in the return operation to the index pulse detection position and over-travel inhibit input is detected.

During homing operation, if a cancellation of homing is executed by halt or other means from a host device during the period from homing detection to completion of homing, Err27.7.0 “Position information initialization error protection” occurs.

### ■ Homing return velocity limit function

Performs a return operation to return by the amount past the home position when the home position is detected. At this time, if homing is performed using a setting with a high response to position commands and at a high speed, such as when two-degree-of-freedom control is enabled, sound may be generated upon completion.

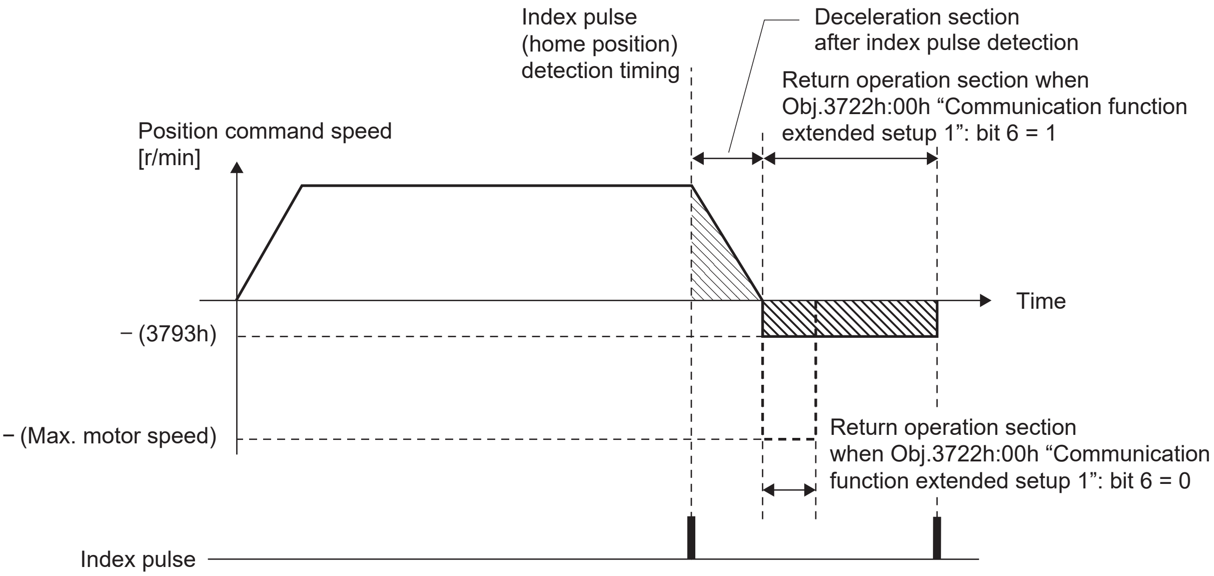
If Obj.3722h:00h “Communication function extended setup 1” :bit 6 “Homing return operation velocity limit enabled” is set to 1 and the homing return velocity limit function is enabled, the return operation speed is limited by the Obj.3793h:00h “Homing return speed limit value” setting value, which is expected to have the effect of reducing sound generation.

If this function is enabled, the time to complete homing may be extended.

When this function is disabled, the return operating speed is limited by the maximum motor speed saved inside the driver.

If the return operation speed exceeds Obj.3513h:00h “Over-speed level setup” , Err26.0.0 “Overspeed protection” occurs, and if the return operation speed exceeds the set value of Obj.3615h:00h “2nd over-speed level setup” , Err26.1.0 “2nd Overspeed protection” occurs.

**Example of homing (positive direction) using index pulse**



—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | R |
| | ● bit 6: Homing return velocity limit enabled<br>0: Disabled<br>1: Enabled | | | | | | | | | |
| 3793h | 00h | Homing return speed limit value | r/min | 0 to 20000 | I16 | rw | No | hm | Yes | C |
| | ● Sets the homing return speed limit value.<br>If the setting value is less than the internal minimum speed, the velocity is limited by the internal minimum speed.<br>If the set value is greater than the maximum motor speed, it is limited by the maximum motor speed. | | | | | | | | | |

## ■ Protection function setup in homing using Z-phase

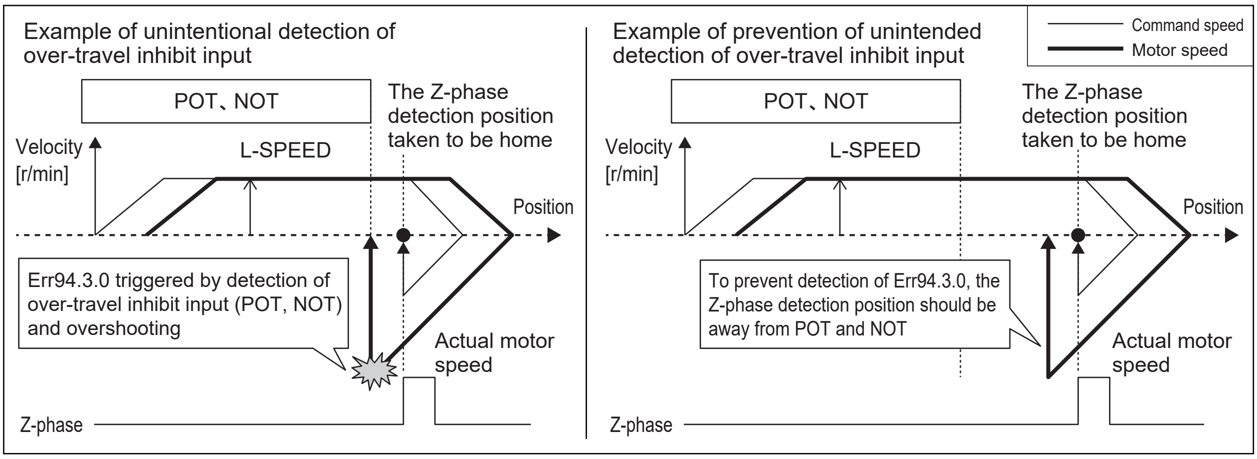
By setting to Obj.3722h:00h "Communication function extended setup 1" :bit 7 "Over-travel inhibit input detection setting during Z-phase homing return operation" = 1, the over-travel inhibit input (POT, NOT) will be detected while returning to the Z-phase detection position, which is treated as the home in homing using the Z-phase.

If over-travel inhibit input is detected during the return operation, Err94.3.0 "Homing error protection 2" can be triggered to enable the protection function used to stop the motor by shutting off current to it.

**— Precautions —**

- If set to Obj.3722h:00h "Communication function extended setup 1" :bit 7 "Over-travel inhibit input detection setting during Z-phase homing return operation" = 1 and the home Z-phase in proximity to over-travel inhibit input (POT, NOT) is taken to be home, Err94.3.0 "Homing error protection 2" may be unintentionally triggered through detection of over-travel inhibit input when the return operation to the Z-phase detection position has overshot.

  In order to prevent unintentional detection of over-travel inhibit inputs, the position at which over-travel inhibit is input must be separated from the Z-phase, which is treated as the position for completing homing. Prevent the return operation from occurring in the proximity of over-travel inhibit input (POT, NOT).



- If not set to Obj.3722h:00h “Communication function extended setup 1” :bit 7 “Over-travel inhibit input detection setting during Z-phase homing return operation” = 1, detection of over-travel inhibit input (POT/ NOT) is disabled during return to the Z-phase detection position when homing by use of the Z-phase.

Related Objects

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3504h | 00h | Over-travel inhibit input setup | – | 0 to 2 | I16 | rw | No | ALL | Yes | C |
| | | Sets the input operations for the over-travel inhibit inputs (POT, NOT).<br>Set according to the host device specification.<br>Normally set to 1 (disabled) in order for the host device to control the operation.<br>● 0: Servo (this product) side deceleration to stop (sequence during over-travel inhibit input)<br>Functions as POT -> Positive direction over-travel inhibit, NOT -> Negative direction over-travel inhibit. Stops as per Obj.3505h:00h “Sequence at over-travel inhibit” when POT is input when operating in a positive direction. Operation is similar when NOT is input when operating in a negative direction.<br>● 1: CoE (CiA402)-side deceleration to stop<br>Functions as POT -> Positive direction over-travel inhibit, NOT -> Negative direction over-travel inhibit. If POT is input during positive direction travel or NOT is input during negative direction travel, the EtherCAT profile deceleration operation defined in CoE (CiA402) is executed to bring it to a stop. The deceleration constant differs for each control mode.<br>● 2: Servo (this product) side deceleration to stop (sequence at alarm)<br>Inputting either POT or NOT triggers Err38.0.0 “Over-travel inhibit input protection 1” . | | | | | | | | |
| 3722h | 00h | Communication function extended setup 1 | – | -32768 to 32767 | I16 | rw | No | ALL | Yes | B |
| | | ● bit 7: Over-travel inhibit input detection setting during Z-phase homing return operation<br>0: Disabled<br>1: Enabled | | | | | | | | |

Related protection functions

| Alarm number | | | Name | Cause | Handling |
|---|---|---|---|---|---|
| Main | Sub | Primary cause | | | |
| 94 | 3 | 0 | Homing error protection 2 | ● Either positive direction or negative direction over-travel inhibit input (POT or NOT) was turned ON during the return operation to the Z-phase position detected during homing using Z-phase while Obj.3722h:00h "Communication function extended setup 1" :bit 7 = 1. | ● Increase the distance between the Z-phase and the positive direction/ negative direction over-travel inhibit input (POT/NOT).<br>● After ensuring safety, set Obj.3722h:00h:bit 7 "Over-travel inhibit input detection setting during Z-phase homing return operation" = 0 (disabled). |

## ■ Conditions for Homing error

The table below shows the conditions that cause an error (Homing error = 1) in the homing operation.

| Conditions for Homing error | Details |
|---|---|
| Start in absolute mode | Homing started in absolute mode (*2) |
| Startup in state other than Operation enabled | Homing started when PDS state is not Operation enabled (*2)<br>(Excluding method 35 and 37) |
| Startup with target speed 0 | Homing started when Obj.6099h:01h "Speed during search for switch" and Obj.6099h:02h "Speed during search for zero" are set to 0 (*2)<br>(except when Obj.6099h:02h "Speed during search for zero" in methods 33 and 34 and Obj.6099h:01h "Speed during search for switch" and Obj.6099h:02h "Speed during search for zero" in methods 35 and 37 are 0) |
| Both limit switches detected | Both positive and negative limit switches detected during homing startup (*2) or homing operation (*3) |
| Limit switch has been passed | In the case of a method that reverses from the limit switch, the falling edge of limit switch is detected during the deceleration operation for reversal after the rising edge of limit switch is detected |
| Home switch was passed | In the case of a method that reverses from the home switch, the falling edge of home switch is detected during the deceleration operation for reversal after the rising edge of home switch is detected |
| Improper installation relationship between home switch and limit switch | In the case of a method that reverses from the home switch, the rising edge of limit switch is detected during the deceleration operation for reversal after the rising edge of home switch is detected |
| | Limit switch is detected during home switch search in a method that is not reversed by limit switch (*1) |
| Inappropriate installation relationship between index pulse and limit switch | In a method that detects index pulses, the rising edge of limit switch is detected during index pulse search |
| | Limit switch is detected during index pulse search in a Method that is not reversed by Limit switch (*1) |
| Home switch and limit switch are not assigned. | When the edge of the switch signal (HOME, POT, NOT) is used as the home detection position, HOME, POT, NOT are not assigned to SI5, SI6, SI7 |

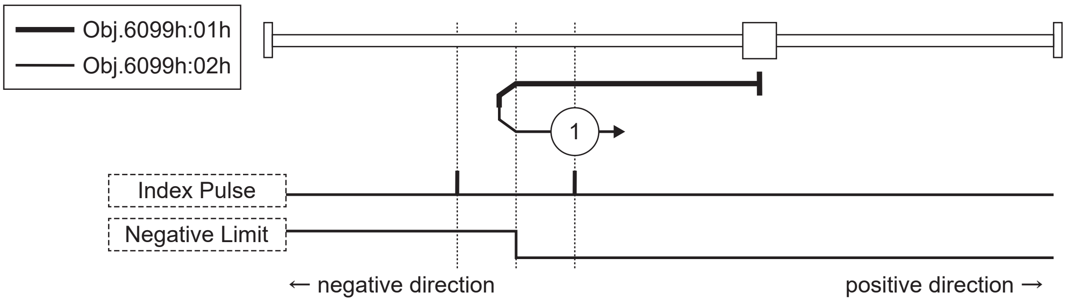
*1 If the limit switch is detected at the time of homing startup (*2) and an operation is performed to exit the limit switch at startup (operation in the opposite direction of the limit direction), a homing error will not be detected.

*2 Homing startup means the timing when Obj.6040h:00h "Controlword" :bit 4 "start homing" receives the change from 0 to 1.

*3 When Obj.3504h:00h "Over-travel inhibit input setup" = 0, no homing error occurs and Err38.0.0 "Over-travel inhibit input protection 1" is generated.

### ■ Method 1

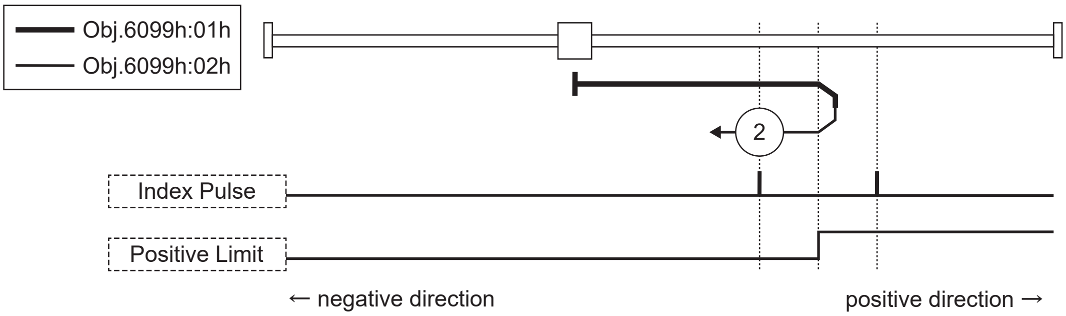
- When the negative limit switch is inactive, the initial operating direction of this method is negative (In the figure below, the inactive state is shown as a low-level state.).
- The home detection position is the first index pulse detection position on the positive side position after the negative limit signal becomes inactive.
- If NOT is not assigned, then Homing error = 1.



Homing on negative limit switch and index pulse

### ■ Method 2

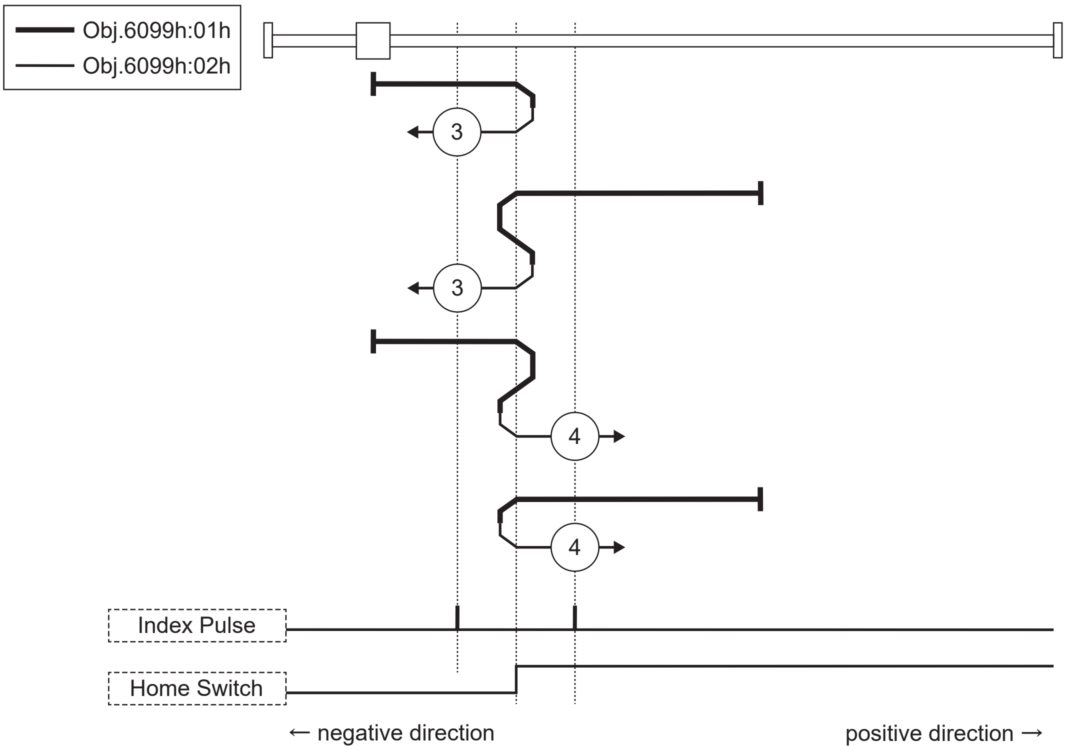
- When the positive limit switch is inactive, the initial operating direction of this Method is positive (In the figure below, the inactive state is shown as a low-level state.).
- The home detection position is the first index pulse detection position on the negative side position after the positive limit signal becomes inactive.
- If POT is not assigned, then Homing error = 1.



Homing on positive limit switch and index pulse

### ■ Method 3, Method 4

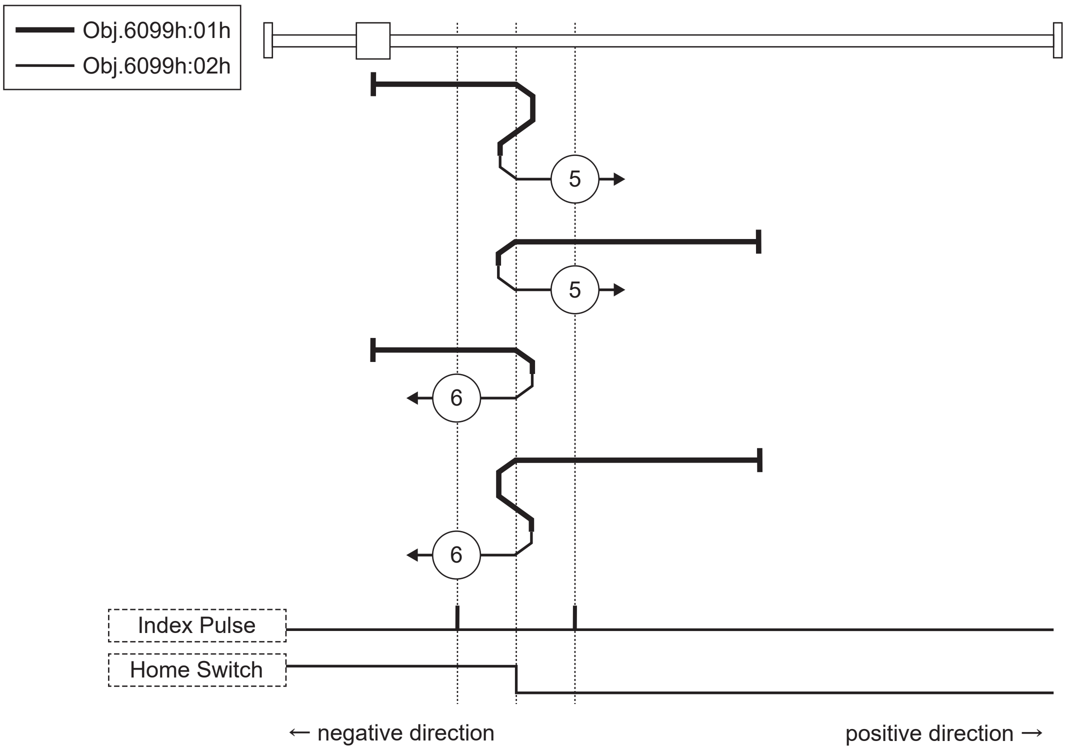
- The initial operating direction of these Methods changes according to the status of the home switch at startup (In the figure below, the inactive state is shown as a low-level state.).
- The home detection position is the first index pulse detection position on the negative or positive side after the home switch state change.
- If HOME is not assigned, then Homing error = 1.



Homing on positive home switch and index pulse

### ■ Method 5, Method 6

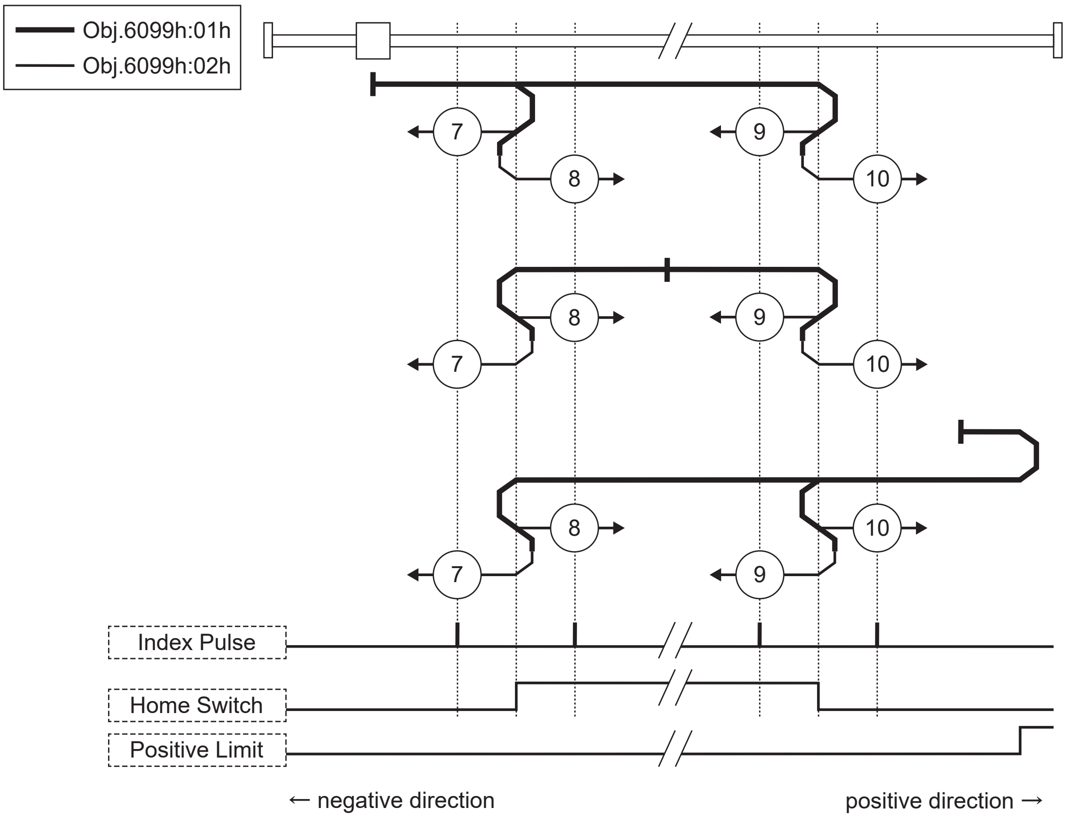
- The initial operating direction of these Methods changes according to the status of the home switch at startup (In the figure below, the inactive state is shown as a low-level state.).
- The home detection position is the first index pulse detection position on the negative or positive side after the home switch state change.
- If HOME is not assigned, then Homing error = 1.



Homing on negative home switch and index pulse

## Method 7, Method 8, Method 9, Method 10

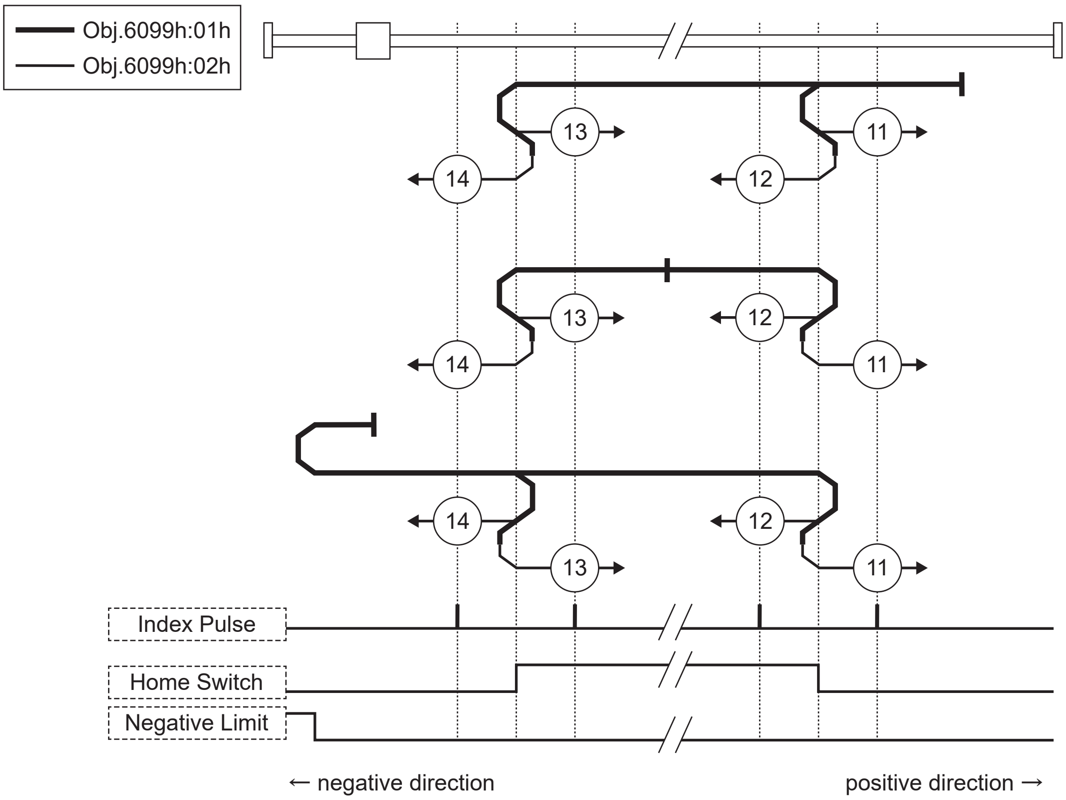
- These methods use Home switch and Index pulse (In the figure below, the inactive state is shown as a low-level state.).
- The initial operating direction of Method 7 and Method 8 is the negative direction if the Home switch is active at the start of operation.
- The initial operating direction of Method 9 and Method 10 is the positive direction if the Home switch is active at the start of operation.
- The home detection position is the index pulse near the rising or falling edge of the Home switch.
- If HOME and POT are not assigned, then Homing error = 1.



Homing on home switch and index pulse - positive initial motion

### ■ Method 11, Method 12, Method 13, Method 14

- ● These methods use Home switch and Index pulse (In the figure below, the inactive state is shown as a low-level state.).
- ● The initial operating direction of Method 11 and Method 12 is the positive direction if the Home switch is active at the start of operation.
- ● The initial operating direction of Method 13 and Method 14 is the negative direction if the Home switch is active at the start of operation.
- ● The home detection position is the index pulse near the rising or falling edge of the Home switch.
- ● If HOME and NOT is not assigned, then Homing error = 1.

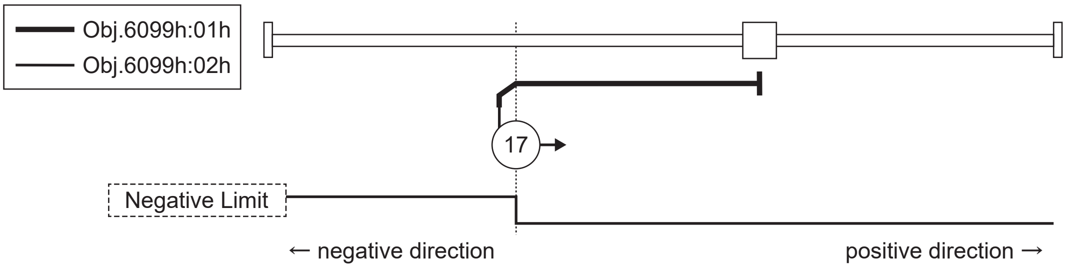


Homing on home switch and index pulse - negative initial motion

## ■ Method 17

- This Method is similar to Method 1.

  The difference from Method 1 is that the home detection position is not the Index pulse, but the position at which the Limit switch changes (In the figure below, the inactive state is shown as a low-level state.).
- If NOT is not assigned to any of SI5, SI6, or SI7, then Homing error = 1.

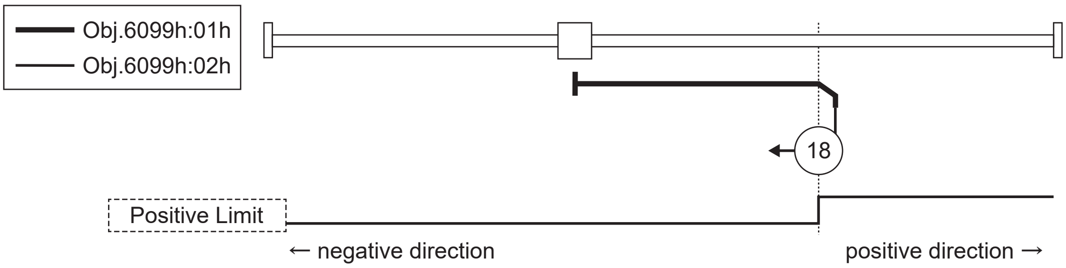


Homing on negative limit switch

## ■ Method 18

- This Method is similar to Method 2.

  The difference from Method 2 is that the home detection position is not the Index pulse, but the position at which the Limit switch changes (In the figure below, the inactive state is shown as a low-level state.).
- If POT is not assigned to any of SI5, SI6, or SI7, then Homing error = 1.

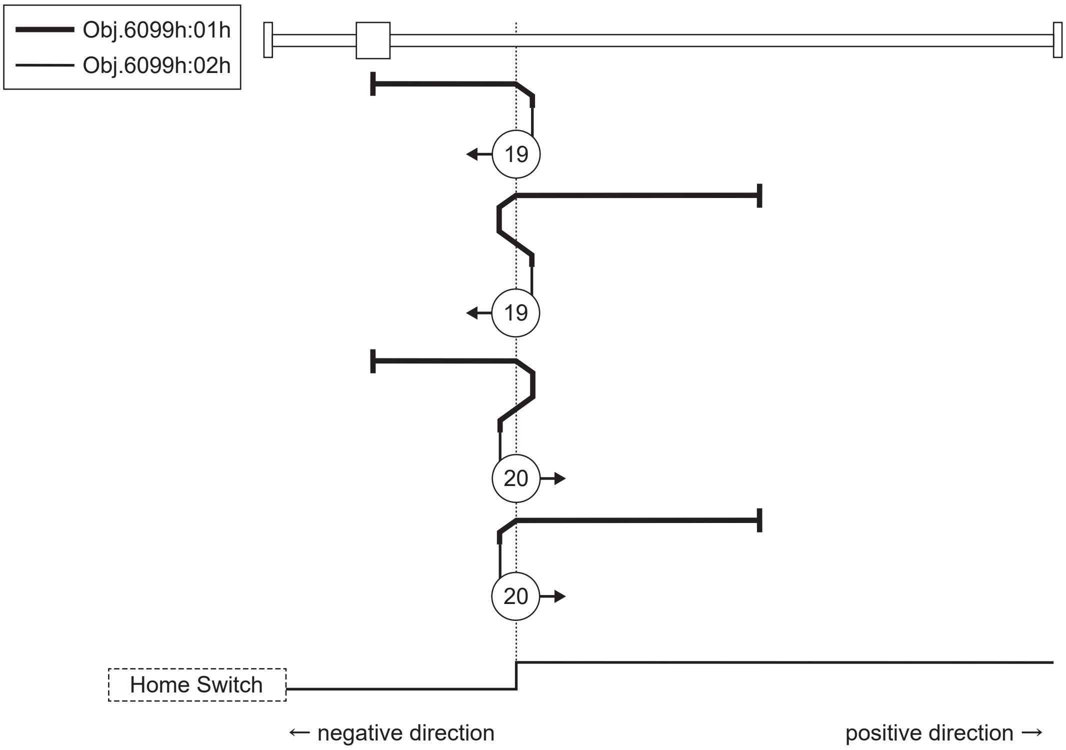


Homing on positive limit switch

### ■ Method 19, Method 20

- These Methods are similar to Method 3 and Method 4.

  The difference from Method 3 and 4 is that the home detection position is not the Index pulse, but the position at which the Home switch changes (In the figure below, the inactive state is shown as a low-level state.).
- If HOME is not assigned to any of SI5, SI6, or SI7, then Homing error = 1.

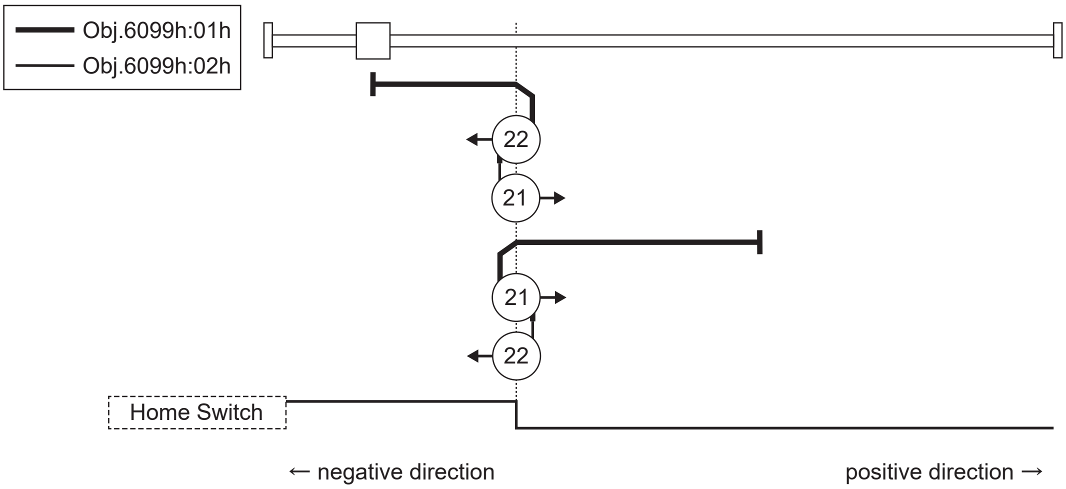


Homing on positive home switch

### ■ Method 21, Method 22

- These Methods are similar to Method 5 and Method 6.

  The difference from Method 5 and 6 is that the home detection position is not the Index pulse, but the position at which the Home switch changes (In the figure below, the inactive state is shown as a low-level state.).
- If HOME is not assigned to any of SI5, SI6, or SI7, then Homing error = 1.

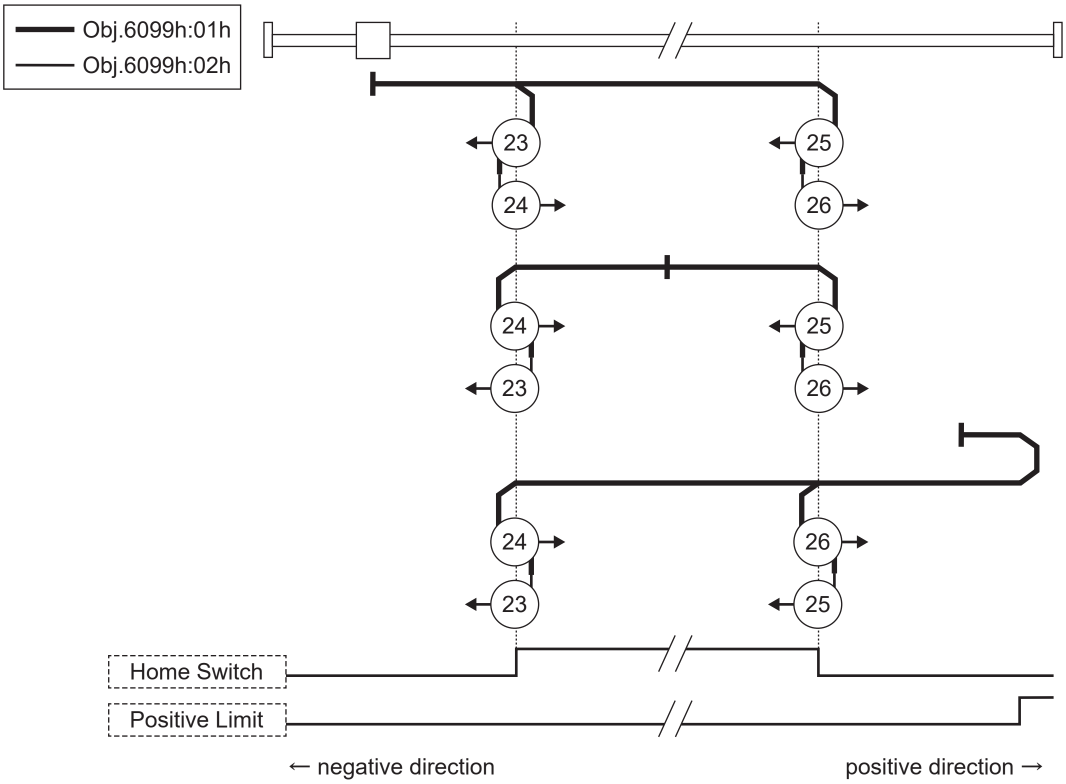


Homing on negative home switch and index pulse

### ■ Method 23, Method 24, Method 25, Method 26

- These methods are similar to Method 7, Method 8, Method 9, and Method 10.

  The difference from methods 7, 8, 9, 10 is that the home detection position is not the Index pulse, but the position at which the Home switch changes (In the figure below, the inactive state is shown as a low-level state.).
- If HOME is not assigned to SI5, SI6, or SI7, or if POT is not assigned, then Homing error = 1.



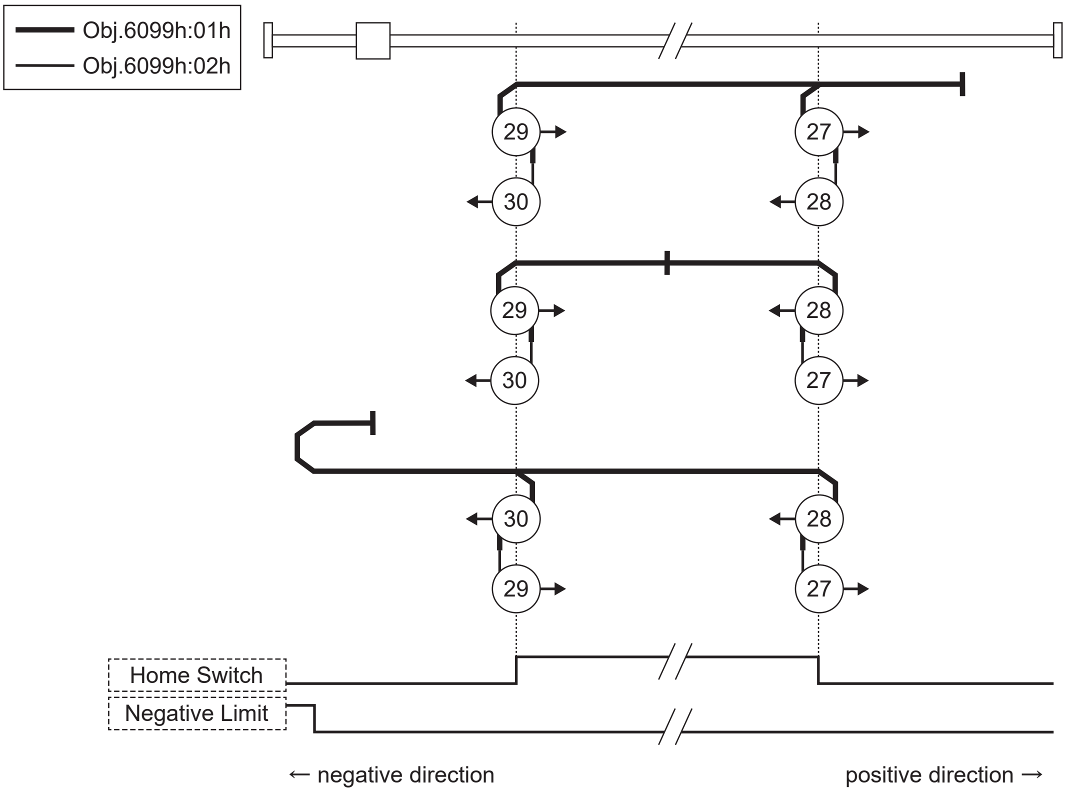
Homing on home switch and index pulse - positive initial motion

### ■ Method 27, Method 28, Method 29, Method 30

- These methods are similar to Method 11, Method 12, Method 13, and Method 14.

  The difference from methods 11, 12, 13, 14 is that the home detection position is not the Index pulse, but the position at which the Home switch changes (In the figure below, the inactive state is shown as a low-level state.).

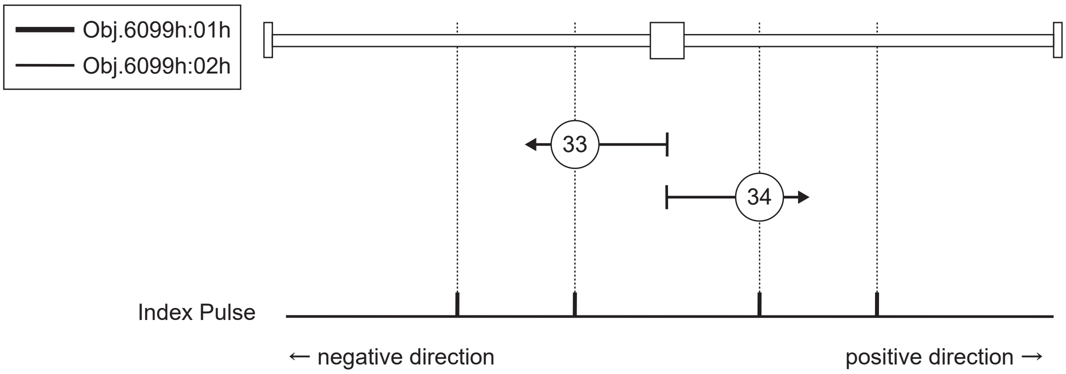
- If HOME is not assigned to SI5, SI6, or SI7, or if NOT is not assigned, then Homing error = 1.



Homing on home switch and index pulse - negative initial motion

### Method 33, Method 34

- These Methods use only Index pulse.
- The Index pulse detected by operation in the direction shown in the figure is used as the home detection position.



Homing on index pulse

### Method 35, Method 37

- Used to set the coordinate system of the product (location information setting).

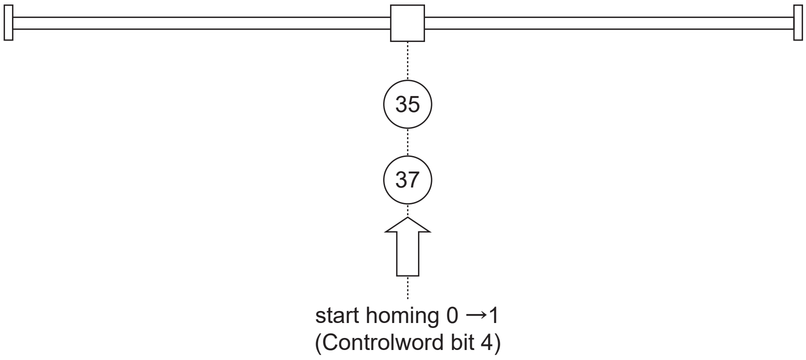
  When homing is started, the following objects are initialized (preset) based on the position.

  Obj.607Ch:00h “Home offset” is added to Obj.6062h:00h “Position demand value” and Obj.6064h:00h “Position actual value” .

  Obj.6062h:00h “Position demand value” = Obj.6064h:00h “Position actual value” = Obj.607Ch:00h “Home offset”

  Obj.6063h:00h “Position actual internal value” = Obj.60FCh:00h “Position demand internal value” = 0
- It can be executed even if the PDS state is not Operation Enabled.

- Method 35 and Method 37 should be executed after a time interval of 100 ms or more after the command position is stopped.
- Method 35 and Method 37 have the same functionality, but for new designs, use Method 37 in accordance with ETG standards.



### 6.6.6 Velocity Control Function (pv, csv)

The following types of velocity control mode are available:

- Profile velocity control (pv)
- Cyclic velocity control (csv)

This section describes the objects used in the velocity control mode functions described above.

For a system overview of velocity control, see *“7.4 Velocity Control”* .

#### 6.6.6.1 Velocity Control Common Functions

This section describes the objects used in functions common to each velocity control mode.

For control block diagrams, see below.

- *“Control block diagram: Velocity control (when two-degree-of-freedom control mode is enabled)”*
- *“Control block diagram: Velocity control (when two-degree-of-freedom control mode is disabled)”*

The control block diagram is described using servo parameter numbers. For the relationship between servo parameter numbers and object numbers, see *“6.4 Servo Parameter Area (3000h to 3FFFh) Details”* .

#### 6.6.6.1.1 Objects Commonly Related to Velocity Control (Command/Setting-related)

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3312h | 00h | Acceleration time setup | ms/ (1000 r/ min) | 0 to 10000 | I16 | rw | No | csv<br>pv | Yes | B |
| 3313h | 00h | Deceleration time setup | ms/ (1000 r/ min) | 0 to 10000 | I16 | rw | No | csv<br>pv | Yes | B |
| 3314h | 00h | Sigmoid acceleration / deceleration time setup | ms | 0 to 1000 | I16 | rw | No | csv<br>pv | Yes | B |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60FFh | 00h | Target velocity | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pv | No | A |

There are other objects associated with each velocity control mode. Also, Obj.6040h:00h “Controlword” has different functions in each velocity control mode. For a description of the associated objects and Obj.6040h:00h “Controlword” functions for each velocity control mode, see below.

- *“6.6.6.2 Profile Velocity Control Mode (pv mode)”*
  1. *“6.6.6.2.1 Objects Related to pv Control Mode (Command/Setting-related)”*
  2. *“6.6.6.2.2 Objects Related to pv Control Mode (Monitoring-related)”*
- *“6.6.6.3 Cyclic Velocity Control Mode (csv mode)”*
  1. *“6.6.6.3.1 Objects Related to csv Control Mode (Command/Setting-related)”*
  2. *“6.6.6.3.2 Objects Related to csv Control Mode (Monitoring-related)”*

##### 6.6.6.1.1.1 Velocity-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3312h | 00h | Acceleration time setup | ms/ (1000 r/ min) | 0 to 10000 | I16 | rw | No | csv<br>pv | Yes | B |
| | | ● Sets the acceleration time for acceleration processing with respect to speed command input. | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3313h | 00h | Deceleration time setup | ms/ (1000 r/ min) | 0 to 10000 | I16 | rw | No | csv<br>pv | Yes | B |
| | | ● Sets the deceleration time for deceleration processing with respect to speed command input. | | | | | | | | |
| 3314h | 00h | Sigmoid acceleration / deceleration time setup | ms | 0 to 1000 | I16 | rw | No | csv<br>pv | Yes | B |
| | | ● Sets the S-curve time for acceleration/deceleration processing with respect to speed command input. | | | | | | | | |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes (*1) | B |
| | | ● Sets the maximum motor speed.<br>● The maximum value is limited to the maximum velocity output by the motor using internal processing. | | | | | | | | |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| | | ● Set the speed command offset value (speed feedforward).<br>● The maximum value is limited with Obj.6080h:00h “Max motor speed” by internal processing. | | | | | | | | |
| 60FFh | 00h | Target velocity | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pv<br>csv | No | A |
| | | ● Sets the target speed.<br>● The setting value of this object and the additional value of Obj.60B1h:00h “Velocity offset” is the internal target speed.<br>● The maximum internal target speed is limited by an internal process to the smaller of Obj.607Fh:00h “Max profile velocity” and Obj.6080h:00h “Max motor speed” . | | | | | | | | |

*1 The value stored in EEPROM is set when the control power is turned on.

### 6.6.6.1.1.2 Torque-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| | | ● If Obj.60FEh:01h “Physical outputs” :bit 19 = 1 is set while Obj.60FEh:02h “Bit mask” :bit 19 = 1, the torque command value generated by the velocity control loop is limited by the setting value. | | | | | | | | |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| | | ● Sets the maximum motor torque.<br>● The maximum value is limited to the maximum torque output by the motor using internal processing.<br>● The maximum motor torque may vary depending on the motor used.<br>● Disabled if ESM state is Init, enabled if ESM state is PreOP or higher. | | | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| | | ● Set the torque command offset value (torque feedforward).<br>● The torque feedforward value is 0 during deceleration in over-travel inhibition operations (during emergency stops). | | | | | | | | |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>60E0h</td><td>00h</td><td>Positive torque limit value</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the positive direction torque limit when Obj.3521h:00h “Selection of torque limit” = 5 is set.<br>Limits the torque command by the smallest value among the limit values of Obj.3013h:00h “1st torque limit” , Obj.3522h:00h “2nd torque limit” and Obj.6072h:00h “Max torque” .</td></tr>
<tr><td>60E1h</td><td>00h</td><td>Negative torque limit value</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the negative direction torque limit when Obj.3521h:00h “Selection of torque limit” = 5 is set.<br>Limits the torque command by the smallest value among the limit values of Obj.3013h:00h “1st torque limit” , Obj.3522h:00h “2nd torque limit” and Obj.6072h:00h “Max torque” .</td></tr>
</table>

### 6.6.6.1.1.3 Other

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>3724h</td><td>00h</td><td>Communication function extended setup 3</td><td>—</td><td>-32768 to 32767</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>C</td></tr>
<tr><td colspan="11">● bit 7: TFF clear ON/OFF selection from host device<br>0: Clear<br>1: Updates using the Obj.60B2h set value</td></tr>
</table>

### 6.6.6.1.2 Objects Commonly Related to Velocity Control (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F41h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | — |
|  | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
|  | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F49h | 00h | External scale absolute position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F87h | 00h | External scale data (Higher) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F88h | 00h | External scale data (Lower) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | Yes | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pv<br>csv | Yes | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | Yes | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | Yes | X |
| 6076h | 00h | Motor rated torque | mN・m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | Yes | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | Yes | X |

There are other objects associated with each velocity control mode. Also, Obj.6041h:00h “Statusword” has different functions in each velocity control mode. For a description of the associated objects and Obj.6041h:00h “Statusword” functions for each velocity control mode, see below.

- *“6.6.6.2 Profile Velocity Control Mode (pv mode)”*
  1. *“6.6.6.2.1 Objects Related to pv Control Mode (Command/Setting-related)”*
  2. *“6.6.6.2.2 Objects Related to pv Control Mode (Monitoring-related)”*
- *“6.6.6.3 Cyclic Velocity Control Mode (csv mode)”*
  1. *“6.6.6.3.1 Objects Related to csv Control Mode (Command/Setting-related)”*
  2. *“6.6.6.3.2 Objects Related to csv Control Mode (Monitoring-related)”*

#### 6.6.6.1.2.1 Position-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays position information for the external scale. | | | | | | | | | |
| 4F41h | — | Motor encoder data | — | — | — | — | — | ALL | — | — |
| | ● Displays position information. | | | | | | | | | |
| 4F41h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of sub-indexes in Obj.4F41h: “Motor encoder data” . | | | | | | | | | |
| 4F41h | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the mechanical angle of the motor (single-turn encoder data). | | | | | | | | | |
| 4F41h | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays multi-turn data of the absolute encoder. | | | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the electrical angle of the motor. | | | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the external scale pulse sum. | | | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the absolute position of the external scale. | | | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the upper 24 bits of the external scale data. | | | | | | | | | |
| 4F88h | 00h | External scale data (Lower) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the lower 24 bits of the external scale data. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual position of the motor.<br>Encoder units except for full-closed control, and external scale units during full-closed control. | | | | | | | | |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual position of the motor. In full-closed control, it is the external scale position. | | | | | | | | |

### 6.6.6.1.2.2 Velocity-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the velocity control command. | | | | | | | | |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual speed sensor value.<br>Not supported by this product and always returns 0. | | | | | | | | |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pv<br>csv | No | X |
| | | ● Displays the internal command speed. | | | | | | | | |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual speed of the motor. | | | | | | | | |

### 6.6.6.1.2.3 Torque-related

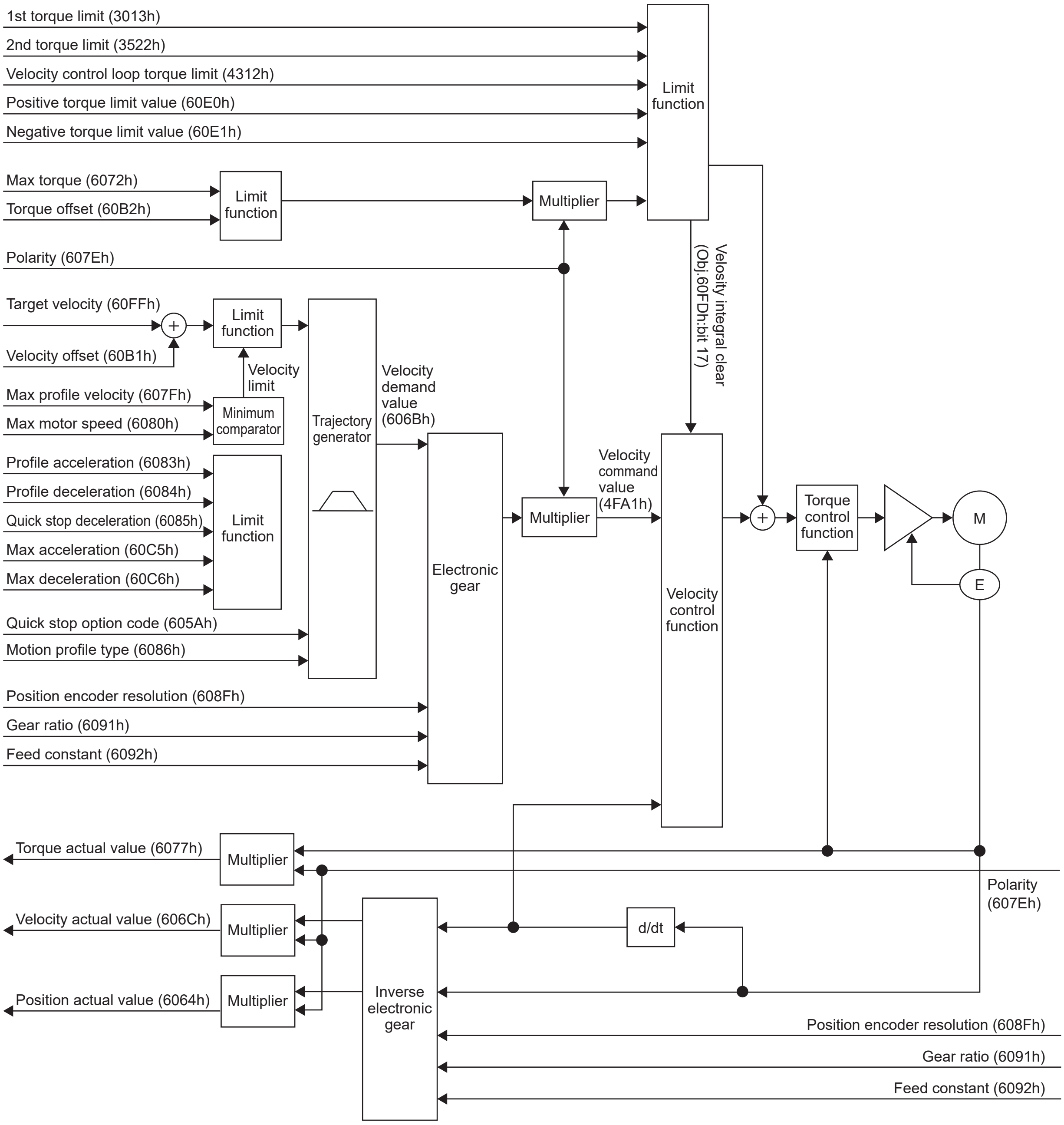
| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | | ● Displays the overload load factor (ratio of motor rated load). | | | | | | | | |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the regenerative load factor (the ratio of regenerative overload protection to the level of alarm occurrence). | | | | | | | | |
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the inertia ratio.<br>Ratio of load inertia to motor rotor inertia (equivalent to the value in Obj.3004h)<br>Inertia ratio = (Load inertia/Rotor inertia) × 100 | | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the positive direction. | | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the negative direction. | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | ● Displays the internal command torque. | | | | | | | | | |
| 6076h | 00h | Motor rated torque | mN･m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| | ● Automatically sets the rated torque from the motor. | | | | | | | | | |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | ● Displays the actual torque.<br>● It is equivalent to the actual current value.<br>● This output value is for reference only and does not guarantee the actual value. | | | | | | | | | |

### 6.6.6.2 Profile Velocity Control Mode (pv mode)

Profile velocity control mode (pv mode) is a velocity control mode in which the host device specifies a target speed, acceleration/deceleration, etc., and this product generates position commands internally.

Use this control mode with a communication cycle of at least 250 µs.



### 6.6.6.2.1 Objects Related to pv Control Mode (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 606Ah | 00h | Sensor selection code | — | -32768 to 32767 | I16 | rw | RxPDO | pv | No | X |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 6083h | 00h | Profile acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 60C5h | 00h | Max acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 60C6h | 00h | Max deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |

There are other related objects common to velocity control. For details, see *“6.6.6.1 Velocity Control Common Functions”* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60FFh | 00h | Target velocity | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pv<br>csv | No | A |

There are other related objects commonly used for motion. For details, see *“6.6.8 Motion Common Functions”* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | — | Position range limit | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |
| 6085h | 00h | Quick stop deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6086h | 00h | Motion profile type | — | -32768 to 32767 | I16 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6092h | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | A |
| 60A3h | 00h | Profile jerk use | — | 1 to 2, 255 | U8 | rw | No | pp<br>pv<br>ip | Yes | A |
| 60A4h | — | Profile jerk | — | — | — | — | — | pp<br>pv<br>ip | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | pp<br>pv<br>ip | No | X |
| | 01h | Profile jerk1 | Command unit/s$^3$ | 0 to 4294967295 | U32 | rw | No | pp<br>pv<br>ip | Yes | A |
| | 02h | Profile jerk2 | Command unit/s$^3$ | 0 to 4294967295 | U32 | rw | No | pp<br>pv<br>ip | Yes | A |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |
| | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

### 6.6.6.2.1.1 Controlword (6040h) (Functions in pv Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands for this product, such as PDS state transitions.
  For the following setting values, the operation mode specific bit is not used in pv control mode.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | | | | | (2) | (3) | (4) | (2) | | | (5) | (6) | (7) | (8) |
| | | | | | | (1) | | | (1) | (1) | (1) | | | | |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on

### 6.6.6.2.1.2 Velocity-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| ● bit 8: Target control mode extension of Obj.607Fh:00h “Max profile velocity”<br>0: Standard specifications (pp, hm, ip, pv)<br>1: Extended specifications (pp, hm, ip, pv, tq, cst) | | | | | | | | | | |
| 606Ah | 00h | Sensor selection code | — | -32768 to 32767 | I16 | rw | RxPDO | pv | No | X |
| ● Set the speed sensor to detect Obj.606Ch:00h “Velocity actual value” .<br>This product does not support speed sensors, so it is always set to 0.<br>0: Detect actual speed from position sensor<br>1: Detect actual speed from speed sensor (not supported) | | | | | | | | | | |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes | B |
| ● Sets the velocity limit value.<br>● The maximum value is limited with Obj.6080h:00h “Max motor speed” by internal processing.<br>● When Obj.3697h:00h “Function expansion setup 3” :bit 8 = 0 is set, this object targets pp, hm, ip, and pv.<br>When Obj.3697h:00h “Function expansion setup 3” :bit 8 = 1 is set, this object targets pp, hm, ip, pv, tq, and cst. | | | | | | | | | | |

### 6.6.6.2.1.3 Acceleration/Deceleration-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6083h | 00h | Profile acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip | Yes | A |
| ● Sets the profile acceleration.<br>● If set to 0, treated as 1 by internal processing. | | | | | | | | | | |
| 6084h | 00h | Profile deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| ● Sets the profile deceleration.<br>● In cyclic position control mode (csp) and cyclic velocity control mode (csv), this is enabled only during deceleration stop sequences.<br>● If set to 0, treated as 1 by internal processing. | | | | | | | | | | |
| 60C5h | 00h | Max acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| ● Sets the maximum acceleration.<br>● If set to 0, treated as 1 by internal processing. | | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60C6h | 00h | Max deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| - Sets the maximum deceleration.<br>- If set to 0, treated as 1 by internal processing. | | | | | | | | | | |

#### 6.6.6.2.2 Objects Related to pv Control Mode (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 606Dh | 00h | Velocity window | Command unit/s | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 606Eh | 00h | Velocity window time | ms | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 606Fh | 00h | Velocity threshold | Command unit/s | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| 6070h | 00h | Velocity threshold time | ms | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |

There are other related objects common to velocity control. For details, see *"6.6.6.1 Velocity Control Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pv<br>csv | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN·m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

### 6.6.6.2.2.1 Statusword (6041h) (Functions in pv Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | (2) | | (3) | (2) | (4) | (1) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | | (13) | (14) | | (15) | | | | | | | | | | |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): max slippage error
(14): speed
(15): target reached

### ■ Bit 13 (operation mode specific (control mode dependent bit)):

—: N/A

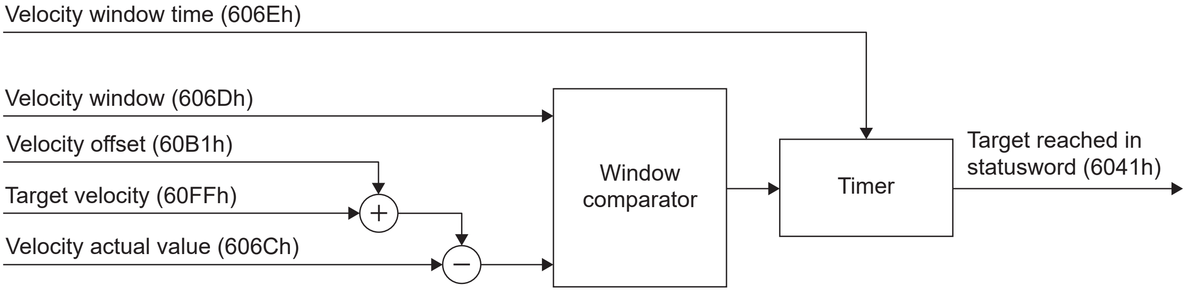
| bit | Name | Value | Definition |
|---|---|---|---|
| 13 | max slippage error | — | (not supported) |

### ■ bit 10 (target reached (Velocity reached)):

If the difference of the sum of Obj.60FFh:00h “Target velocity” and Obj.60B1h:00h “Velocity offset” with Obj.606Ch:00h “Velocity actual value” is within the range set for Obj.606Dh:00h “Velocity window” and the time set for Obj.606Eh:00h “Velocity window time” has elapsed, Obj.6041h:00h “Statusword” :bit 10 is set to 1.

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt = 0 (normal): Velocity control not complete<br>halt = 1 (when stopped by halt): Axis decelerating |
| | | 1 | halt = 0 (normal): Velocity control complete<br>halt = 1 (when stopped by halt): Axis stopped (axis speed is 0) |

### Velocity reached (functional overview)



| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 606Dh | 00h | Velocity window | Com-mand unit/s | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| | | • Sets the threshold value at which Obj.6041h:00h "Statusword" :bit 10 "target reached" becomes 1 when the difference between the sum of Obj.60FFh:00h "Target velocity" and Obj.60B1h:00h "Velocity offset" and Obj.606Ch:00h "Velocity actual value" is within the value set in this parameter and the time set in Obj.606Eh:00h "Velocity window time" elapses.<br>If the speed deviation is outside the setting value of this parameter, Obj.6041h:00h "Statusword" :bit 10 is set to 0. | | | | | | | | |
| 606Eh | 00h | Velocity window time | ms | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| | | • Set the time until Obj.6041h:00h "Statusword" :bit 10 "target reached" becomes 1 after the sum of Obj.60FFh:00h "Target velocity" and Obj.60B1h:00h "Velocity offset" and the Obj.606Ch:00h "Velocity actual value" difference reach the set value of Obj.606Dh:00h "Velocity window" . | | | | | | | | |

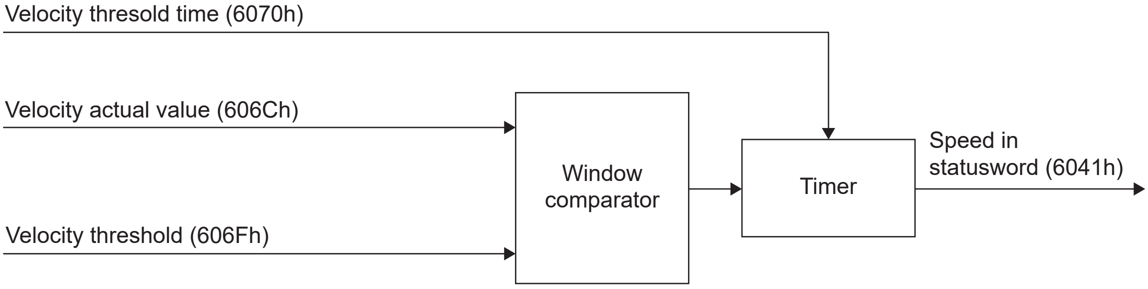
### ■ bit 12 (speed):

If Obj.606Ch:00h "Velocity actual value" exceeds the value set for Obj.606Fh:00h "Velocity threshold" and the time set for Obj.6070h:00h "Velocity threshold time" has elapsed, Obj.6041h:00h "Statusword" :bit 12 is set to 0.

When Obj.606Ch:00h "Velocity actual value" falls below the value set for Obj.606Fh:00h "Velocity threshold" , Obj.6041h:00h "Statusword" :bit 12 is set to 1, indicating that the motor has stopped.

| bit | Name | Value | Definition |
|---|---|---|---|
| 12 | speed | 0 | Motor in operation |
| | | 1 | Motor stopped |

### Speed (functional overview)



| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 606Fh | 00h | Velocity threshold | Command unit/s | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| | ● Set the threshold value at which Obj.6041h:00h “Statusword” :bit 12 “speed” becomes 0 when Obj.606Ch:00h “Velocity actual value” exceeds the value set in this parameter and the time set in Obj.6070h:00h “Velocity threshold time” elapses. If the speed is less than the value set in this parameter, Obj.6041h:00h “Statusword” :bit 12 is set to 1. | | | | | | | | | |
| 6070h | 00h | Velocity threshold time | ms | 0 to 65535 | U16 | rw | RxPDO | pv | Yes | A |
| | ● Sets the time until Obj.6041h:00h “Statusword” :bit 12 becomes 0 when Obj.606Ch:00h “Velocity actual value” exceeds the value set in Obj.606Fh:00h “Velocity threshold” . | | | | | | | | | |

#### 6.6.6.2.3 Operation in pv Control Mode

Profile velocity control mode generates speed command values according to the following parameters.

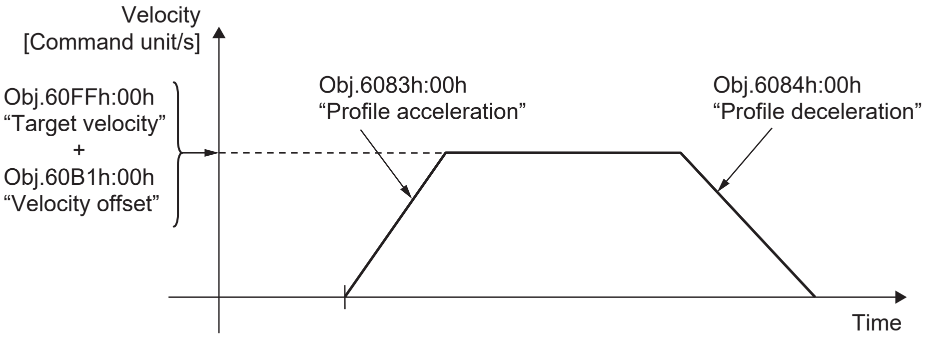
- Obj.60FFh:00h “Target velocity”
- Obj.60B1h:00h “Velocity offset”
- Obj.6083h:00h “Profile acceleration”
- Obj.6084h:00h “Profile deceleration”

The target speed is the sum of Obj.60FFh:00h “Target velocity” and Obj.60B1h:00h “Velocity offset” .

Input the operation command update (transmission) after approximately 100 ms have elapsed since servo-on command (operation enabled command).

Various sensors exist for speed detection, but this product uses an encoder (position sensor) to detect position and speed.

Obj.606Ch:00h “Velocity actual value” etc. is provided as monitoring information.



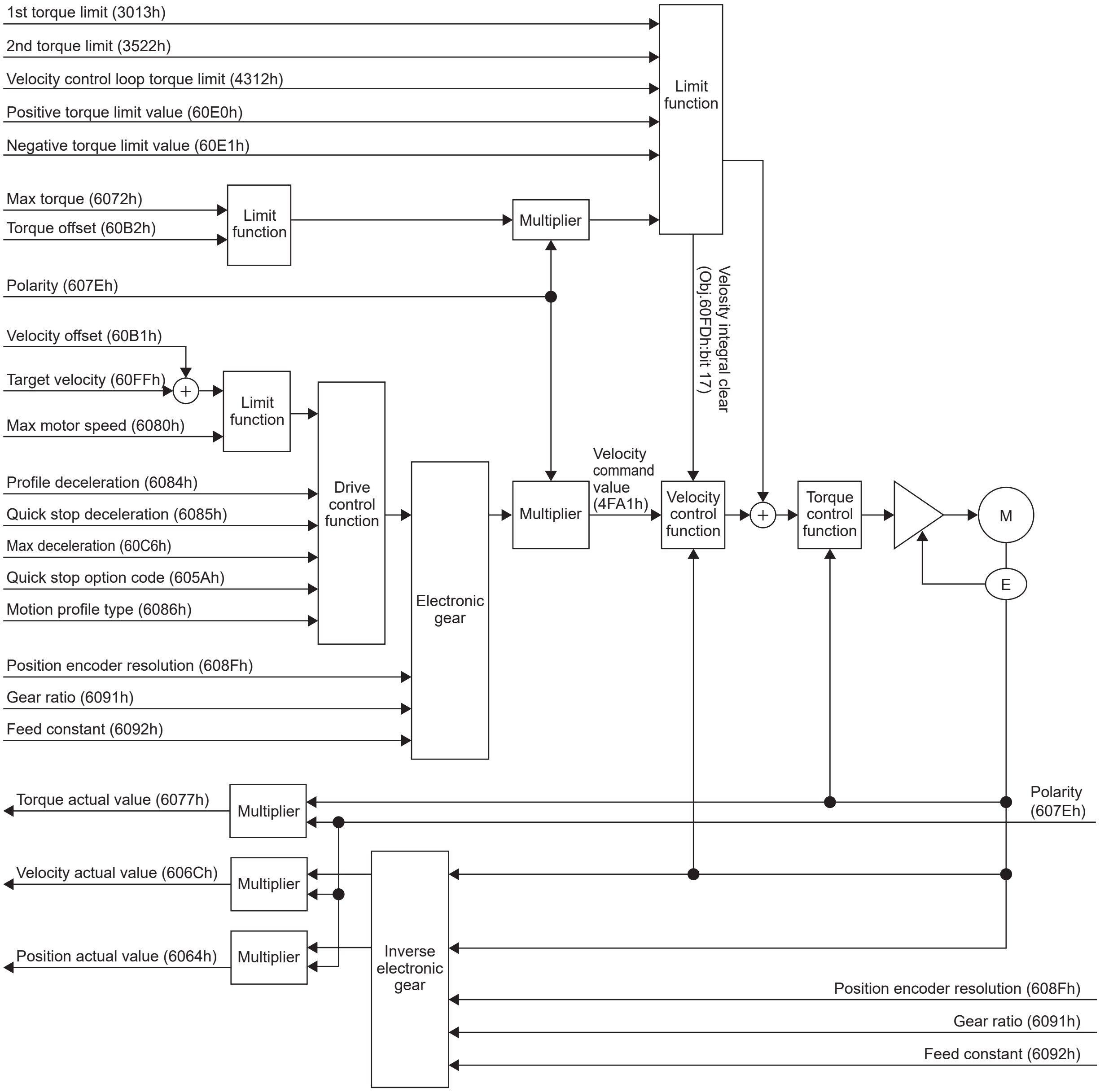
**— Precautions —**

- The sum of Obj.60FFh:00h “Target velocity” and Obj.60B1h:00h “Velocity offset” is limited by the minimum value of Obj.607Fh:00h “Max profile velocity” , Obj.6080h:00h “Max motor speed” , and 2147483647. However, changes to the Obj.607Fh:00h “Max profile velocity” and Obj.6080h:00h “Max motor speed” settings are not reflected during operation.

### 6.6.6.3 Cyclic Velocity Control Mode (csv mode)

Cyclic velocity control mode (csv mode) is a velocity control mode in which the host device generates speed commands and updates (transmits) the command speed in a communication cycle.

Use in DC or SM2 synchronous mode.



### 6.6.6.3.1 Objects Related to csv Control Mode (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |

There are other related objects common to velocity control. For details, see *“6.6.6.1 Velocity Control Common Functions”* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 60B1h | 00h | Velocity offset | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60FFh | 00h | Target velocity | Command unit/s | -2147483648 to 2147483647 | I32 | rw | RxPDO | pv<br>csv | No | A |

There are other related objects commonly used for motion. For details, see *“6.6.8 Motion Common Functions”* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | — | Position range limit | — | — | — | — | — | ALL | — | — |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Bh | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6085h | 00h | Quick stop deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60C2h | — | Interpolation time period | — | — | — | — | — | ip<br>csp<br>csv<br>cst | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ip<br>csp<br>csv<br>cst | No | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60C2h | 01h | Interpolation time period value | — | 0 to 255 | U8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| | 02h | Interpolation time index | — | -128 to 63 | I8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |
| | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

### 6.6.6.3.1.1 Controlword (6040h) (Functions in csv Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands to the product, such as PDS state transitions.

  For the following setting values, the operation mode specific bit is not used csv control mode.

Bit data reference

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | | | | | (2) | (3) | (4) | (2) | | | (5) | (6) | (7) | (8) |
| | | | | | | (1) | | | (1) | (1) | (1) | | | | |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on

### 6.6.6.3.1.2 Other

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |

- bit 11: Condition setting for Obj.6041h: bit 12 “drive follows command value”
  0: Includes torque limit and speed limit (cst only)
  1: Does not include torque limit and speed limit (cst only)

#### 6.6.6.3.2 Objects Related to csv Control Mode (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

There are other related objects common to velocity control. For details, see *"6.6.6.1 Velocity Control Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Bh | 00h | Velocity demand value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | pv<br>csv | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN･m | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

### 6.6.6.3.2.1 Statusword (6041h) (Functions in csv Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

Bit data reference

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2">(1)</td><td colspan="2">(2)</td><td rowspan="2">(3)</td><td>(2)</td><td rowspan="2">(4)</td><td rowspan="2">(1)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td><td rowspan="2">(9)</td><td rowspan="2">(10)</td><td rowspan="2">(11)</td><td rowspan="2">(12)</td></tr>
<tr><td>(1)</td><td>(13)</td><td>(1)</td></tr>
</table>

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): drive follows command value

## ■ Bit 13, 12, 10 (operation mode specific (control mode dependent bit)):

—: N/A

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | — | Not used |
| 12 | drive follows command value | 0 | Operation is not executed according to the target speed (*1) |
| | | 1 | Operation was executed according to the target speed (*1) |
| 13 | reserved | — | Not used |

*1 An “operation has been executed according to the target speed” means that all of the following conditions have been met.

- PDS status is Operation enabled
- Not in a deceleration process (Halt, POT, NOT, Quickstop, Shutdown, Disable operation, Fault)
- Not in halt stop state
- POT is not detected during a positive direction operation command or NOT is not detected during a negative direction operation command
- Torque limit has not triggered (when Obj.3724h:00h “Communication function extended setup 3” :bit 11 = 0)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| ● bit 11: Condition setting for Obj.6041h: bit 12 “drive follows command value”<br>0: Includes torque limit and speed limit (cst only)<br>1: Does not include torque limit and speed limit (cst only) | | | | | | | | | | |

### 6.6.6.3.3 Operation in csv Control Mode

In cyclic velocity control mode, the motion profile (trajectory) is generated by the main device, not the sub device.

The target speed is the sum of Obj.60FFh:00h “Target velocity” and Obj.60B1h:00h “Velocity offset” .

Input the operation command update (transmission) after approximately 100 ms have elapsed since servo-on command (operation enabled command).

Obj.60C2h: “Interpolation time period” indicates a cycle of updating two objects, Obj.60FFh:00h “Target velocity” and Obj.60B1h:00h “Velocity offset” . This value is set to the same cycle as Obj.1C32h:02h “Cycle time” .

Obj.606Ch:00h “Velocity actual value” etc. is provided as monitoring information.

**— Precautions —**

- The sum of Obj.60FFh:00h “Target velocity” and Obj.60B1h:00h “Velocity offset” is limited by the smaller of Obj.6080h:00h “Max motor speed” and 2147483647. However, changes to the Obj.6080h:00h “Max motor speed” setting value are not reflected during operation.

## 6.6.7 Torque Control Function (tq, cst)

The following types of torque control mode are available.

- Profile torque control (tq)
- Cyclic torque control (cst)

This section describes the objects used in the torque control mode functions described above. For a system overview of torque control, see *"7.5 Torque Control"* .

### 6.6.7.1 Torque Control Common Functions

This section describes objects used in functions common to each torque control mode.

For control block diagrams, see below.

- *"Control block diagram: Torque control"*

The control block diagram is described using servo parameter numbers. For the relationship between servo parameter numbers and object numbers, see *"6.4 Servo Parameter Area (3000h to 3FFFh) Details"* .

### 6.6.7.1.1 Objects Commonly Related to Torque Control (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | tq<br>cst | No | A |
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | tq<br>cst | No | A |
| 6071h | 00h | Target torque | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | tq<br>cst | Yes | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | tq<br>cst | Yes | A |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | B (*1) |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | B |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | tq<br>cst | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | tq<br>cst | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | tq<br>cst | Yes | A |

*1 Supported only when Obj.3697h:00h “Function expansion setup 3” :bit 8 = 1 (extended specification) is set. The factory default value is bit 8=0 (standard specification), so change the setting before use.

There are other objects associated with each torque control mode. Also, Obj.6040h:00h “Controlword” has different functions in each torque control mode. For a description of the associated objects and Obj.6040h:00h “Controlword” functions for each torque control mode, see below.

- *“6.6.7.2 Profile Torque Control Mode (tq mode)”*
  1. *“6.6.7.2.1 Objects Related to tq Control Mode (Command/Setting-related)”*
  2. *“6.6.7.2.2 Objects Related to tq Control Mode (Monitoring-related)”*
- *“6.6.7.3 Cyclic Torque Control Mode (cst mode)”*
  1. *“6.6.7.3.1 Objects Related to cst Control Mode (Command/Setting-related)”*
  2. *“6.6.7.3.2 Objects Related to cst Control Mode (Monitoring-related)”*

#### 6.6.7.1.1.1 Velocity-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| ● bit 8: Target control mode extension of Obj.607Fh:00h “Max profile velocity”<br>0: Standard specifications (pp, hm, ip, pv)<br>1: Extended specifications (pp, hm, ip, pv, tq, cst) | | | | | | | | | | |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>607Fh</td><td>00h</td><td>Max profile velocity</td><td>Command unit/s</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>B</td></tr>
<tr><td></td><td colspan="10">● Sets the velocity limit value.<br>● The maximum value is limited with Obj.6080h:00h “Max motor speed” by internal processing.<br>● When Obj.3697h:00h “Function expansion setup 3” :bit 8 is set to 0, the supported control modes are pp, hm, ip, and pv.<br>When Obj.3697h:00h “Function expansion setup 3” :bit 8 is set to 1, the supported control modes are pp, hm, ip, pv, tq, and cst.</td></tr>
<tr><td>6080h</td><td>00h</td><td>Max motor speed</td><td>r/min</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>B</td></tr>
<tr><td></td><td colspan="10">● Sets the maximum motor speed.<br>● The maximum value is limited to the maximum velocity output by the motor using internal processing.</td></tr>
</table>

### 6.6.7.1.1.2 Torque-related

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4312h</td><td>00h</td><td>Velocity control loop torque limit</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>No</td><td>A</td></tr>
<tr><td></td><td colspan="10">● If Obj.60FEh:01h “Physical outputs” :bit 19 = 1 is set in the state of Obj.60FEh:02h “Bit mask” :bit 19 = 1, the torque command value generated from the velocity control loop will be limited by the setting value.</td></tr>
<tr><td>6071h</td><td>00h</td><td>Target torque</td><td>0.1%</td><td>-32768 to 32767</td><td>I16</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>A</td></tr>
<tr><td></td><td colspan="10">● Set the target torque in profile torque control mode (tq) and cyclic torque control mode (cst).<br>For values greater than Obj.6072h:00h “Max torque” , the value is limited by Obj.6072h.</td></tr>
<tr><td>6072h</td><td>00h</td><td>Max torque</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>A</td></tr>
<tr><td></td><td colspan="10">● Sets the maximum motor torque.<br>● The maximum value is limited to the maximum torque output by the motor using internal processing.<br>● The maximum motor torque may vary depending on the motor used.<br>● Disabled if ESM state is Init, enabled if ESM state is PreOP or higher.</td></tr>
<tr><td>6087h</td><td>00h</td><td>Torque slope</td><td>0.1%/s</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>A</td></tr>
<tr><td></td><td colspan="10">● Sets the parameter value to give a gradient to the torque command.<br>● In cyclic torque control mode (cst), this is enabled only during deceleration to stop sequences.<br>● If set to 0, treated as 1 by internal processing.</td></tr>
<tr><td>60B2h</td><td>00h</td><td>Torque offset</td><td>0.1%</td><td>-32768 to 32767</td><td>I16</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>A</td></tr>
<tr><td></td><td colspan="10">● Set the torque command offset value (torque feedforward).<br>● The torque feedforward value is 0 during deceleration in over-travel inhibition operations (during emergency stops).</td></tr>
<tr><td>60E0h</td><td>00h</td><td>Positive torque limit value</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>tq<br>cst</td><td>Yes</td><td>A</td></tr>
<tr><td></td><td colspan="10">● Sets the positive direction torque limit when Obj.3521h:00h “Selection of torque limit” = 5 is set.<br>Limit the torque command by the minimum value among the following object limit values.<br>• Obj.3013h:00h “1st torque limit”<br>• Obj.3522h:00h “2nd torque limit”<br>• Obj.6072h:00h “Max torque”</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | tq<br>cst | Yes | A |

- Sets the negative direction torque limit when Obj.3521h:00h “Selection of torque limit” = 5 is set.
  Limit the torque command by the minimum value among the following object limit values.
  - Obj.3013h:00h “1st torque limit”
  - Obj.3522h:00h “2nd torque limit”
  - Obj.6072h:00h “Max torque”

### 6.6.7.1.2 Objects Commonly Related to Torque Control (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 4F0Dh | 00h | External scale position | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F41h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| 4F48h | 00h | External scale pulse total | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F49h | 00h | External scale absolute position | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F87h | 00h | External scale data (Higher) | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F88h | 00h | External scale data (Lower) | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6075h | 00h | Motor rated current | mA | 0 to 4294967295 | U32 | rw | No | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN·m | 0 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6078h | 00h | Current actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6079h | 00h | DC link circuit voltage | mV | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

There are other objects associated with each torque control mode. Also, Obj.6041h:00h “Statusword” has different functions in each torque control mode. For a description of the associated objects and Obj.6041h:00h “Statusword” functions for each torque control mode, see below.

- *“6.6.7.2 Profile Torque Control Mode (tq mode)”*
  1. *“6.6.7.2.1 Objects Related to tq Control Mode (Command/Setting-related)”*
  2. *“6.6.7.2.2 Objects Related to tq Control Mode (Monitoring-related)”*
- *“6.6.7.3 Cyclic Torque Control Mode (cst mode)”*
  1. *“6.6.7.3.1 Objects Related to cst Control Mode (Command/Setting-related)”*
  2. *“6.6.7.3.2 Objects Related to cst Control Mode (Monitoring-related)”*

### 6.6.7.1.2.1 Position-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays position information for the external scale. | | | | | | | | | |
| 4F41h | — | Motor encoder data | — | — | — | — | — | — | — | — |
| | • Displays position information. | | | | | | | | | |
| 4F41h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | • Displays the number of sub-indexes in Obj.4F41h: “Motor encoder data” . | | | | | | | | | |
| 4F41h | 01h | Mechanical angle (Single-turn data) | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the mechanical angle of the motor (single-turn encoder data). | | | | | | | | | |
| 4F41h | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays multi-turn data of the absolute encoder. | | | | | | | | | |
| 4F42h | 00h | Electrical angle | 0.0879° | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | • Displays the electrical angle of the motor. | | | | | | | | | |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the external scale pulse sum. | | | | | | | | | |
| 4F49h | 00h | External scale absolute position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the absolute position of the external scale. | | | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the upper 24 bits of the external scale data. | | | | | | | | | |
| 4F88h | 00h | External scale data (Lower) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the lower 24 bits of the external scale data. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual position of the motor.<br>Encoder units except for full-closed control, and external scale units during full-closed control. | | | | | | | | |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual position of the motor. In full-closed control, it is the external scale position. | | | | | | | | |

### 6.6.7.1.2.2 Velocity-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the velocity control command. | | | | | | | | |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual speed sensor value.<br>Not supported by this product and always returns 0. | | | | | | | | |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the actual speed (= FSPD) of the motor. | | | | | | | | |

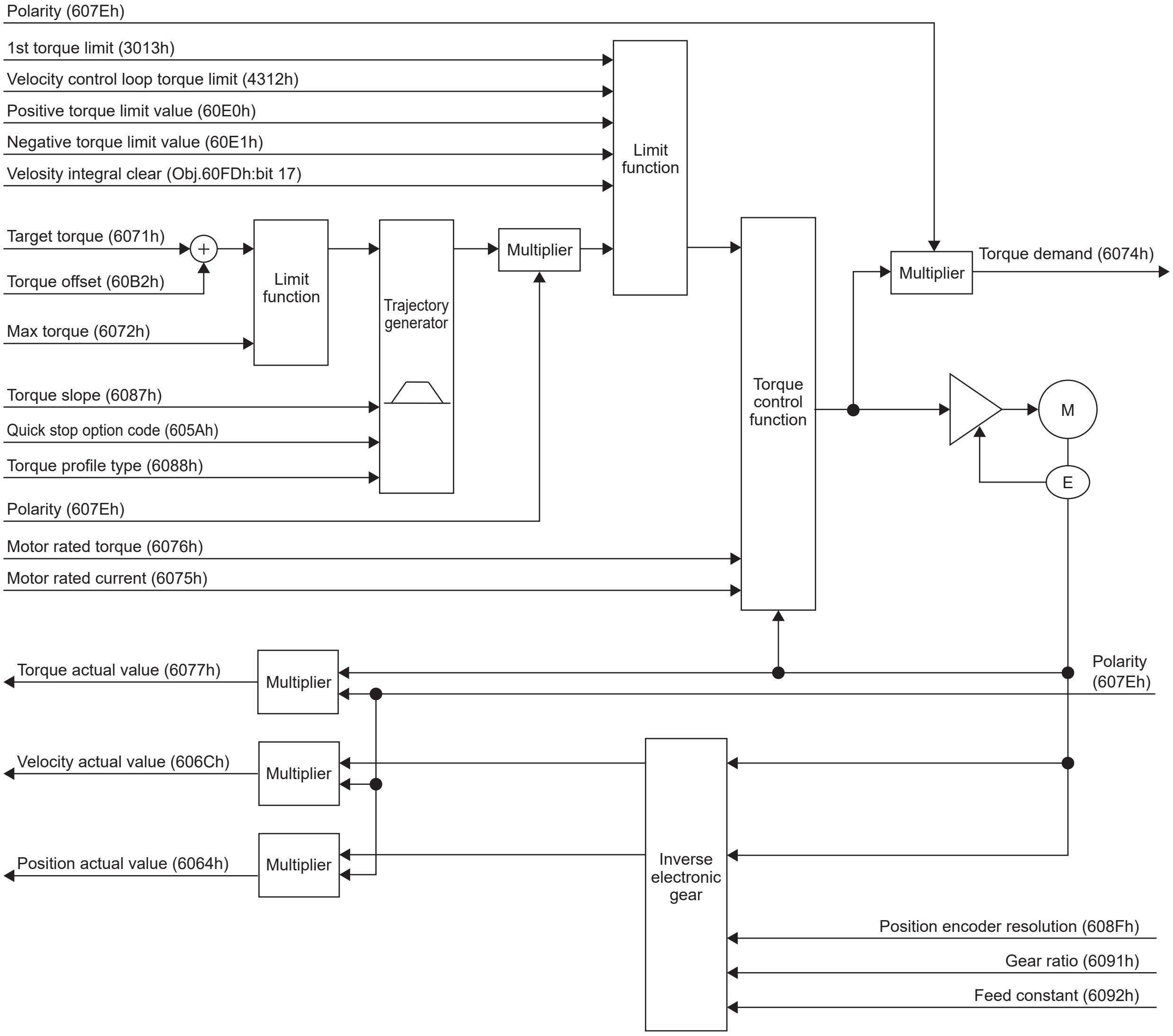
### 6.6.7.1.2.3 Torque-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | | ● Displays the overload load factor (ratio of motor rated load). | | | | | | | | |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the regenerative load factor (the ratio of regenerative overload protection to the level of alarm occurrence). | | | | | | | | |
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the inertia ratio.<br>Ratio of load inertia to motor rotor inertia (equivalent to the value in Obj.3004h)<br>Inertia ratio = (Load inertia/Rotor inertia) × 100 | | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the positive direction. | | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the negative direction. | | | | | | | | |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | | ● Indicates the internal command torque. | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6075h | 00h | Motor rated current | mA | 0 to 4294967295 | U32 | rw | No | ALL | No | X |
| | | • The motor rated current is automatically set.<br>• The access setting is rw, but writing does not reflect the value. | | | | | | | | |
| 6076h | 00h | Motor rated torque | mN･m | 0 to 4294967295 | U32 | ro | No | ALL | No | X |
| | | • The motor rated torque is automatically set. | | | | | | | | |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | | • Displays the actual torque.<br>• This output value is a reference value calculated from the actual current and does not guarantee the actual value. | | | | | | | | |
| 6078h | 00h | Current actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| | | • Displays the actual current value.<br>• This output value may not match the internal command torque. | | | | | | | | |
| 6079h | 00h | DC link circuit voltage | mV | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |
| | | • Displays the voltage across PN of the main circuit power supply. | | | | | | | | |

### 6.6.7.2 Profile Torque Control Mode (tq mode)

Profile torque control mode (tq mode) is a torque control mode in which the host device specifies a target torque, acceleration/deceleration, etc., and this product generates position commands internally.



### 6.6.7.2.1 Objects Related to tq Control Mode (Command/Setting-related)

―: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | ― | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6088h | 00h | Torque profile type | ― | -32768 to 32767 | I16 | rw | RxPDO | tq | Yes | A |

There are other related objects common to torque control. For details, see *"6.6.7.1 Torque Control Common Functions"* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6071h | 00h | Target torque | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | tq<br>cst | Yes | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>ip<br>pv | Yes | B |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

―: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | ― | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | ― | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | ― | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | ― | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | ― | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | ― | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | ― | Position range limit | ― | ― | ― | ― | ― | ALL | ― | ― |
| | 00h | Highest sub-index supported | ― | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
|  | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
|  | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
|  | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — |  |
|  | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
|  | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
|  | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
|  | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |
|  | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

### 6.6.7.2.1.1 Controlword (6040h) (Functions in tq Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands for this product, such as PDS state transitions.
  For the following setting values, the operation mode specific bit is not used in tq control mode.

bit information details

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | | | | | (2) | (3) | (4) | (2) | | | (5) | (6) | (7) | (8) |
| | | | | | | (1) | | | (1) | (1) | (1) | | | | |

(1): reserved (not supported)

(2): operation mode specific (control mode dependent bit)

(3): halt

(4): fault reset

(5): enable operation

(6): quick stop

(7): enable voltage

(8): switch on

### 6.6.7.2.1.2 Torque-related

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |

- Sets the parameter value to give a gradient to the torque command.
- In cyclic torque control mode (cst), this is enabled only during deceleration to stop sequences.
- If set to 0, treated as 1 by internal processing.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6088h | 00h | Torque profile type | — | -32768 to 32767 | I16 | rw | RxPDO | tq | Yes | A |

- Sets the torque profile type used to perform torque changes.
  0: Straight line slope
  1: Not supported (sin2 slope)

#### 6.6.7.2.2 Objects Related to tq Control Mode (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 6073h | 00h | Max current | 0.1% | 0 to 65535 | U16 | rw | No | tq | No | X |

There are other related objects common to torque control. For details, see *"6.6.7.1 Torque Control Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6075h | 00h | Motor rated current | mA | 0 to 4294967295 | U32 | rw | No | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN･m | 0 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6078h | 00h | Current actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6079h | 00h | DC link circuit voltage | mV | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

### 6.6.7.2.2.1 Statusword (6041h) (Functions in tq Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the status of the product.

bit information details

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="2" rowspan="2">(1)</td><td colspan="2">(2)</td><td rowspan="2">(3)</td><td>(2)</td><td rowspan="2">(4)</td><td rowspan="2">(1)</td><td rowspan="2">(5)</td><td rowspan="2">(6)</td><td rowspan="2">(7)</td><td rowspan="2">(8)</td><td rowspan="2">(9)</td><td rowspan="2">(10)</td><td rowspan="2">(11)</td><td rowspan="2">(12)</td></tr>
<tr><td>(1)</td><td>(1)</td><td>(13)</td></tr>
</table>

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): target reached

■ **Bit 13, 12, 10 (operation mode specific (control mode dependent bit)):**

—: N/A

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | target reached | 0 | halt = 0 (normal): Obj.6074h:00h "Torque demand" has not reached target torque<br>halt = 1 (when stopped by halt): Axis decelerating |
| | | 1 | halt = 0 (normal): Obj.6074h:00h "Torque demand" has reached target torque<br>halt = 1 (when stopped by halt): Axis stopped (axis speed is 0) |
| 12 | (reserved) | — | Not used |
| 13 | (reserved) | — | Not used |

### 6.6.7.2.2.2 Torque-related

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6073h | 00h | Max current | 0.1% | 0 to 65535 | U16 | rw | No | tq | No | X |

- Displays the maximum current.
- The access setting is rw, but writing does not reflect the value.

### 6.6.7.2.3 Operation in tq Control Mode

Profile torque control mode generates torque command values according to the following parameters.

Obj.6071h:00h "Target torque"

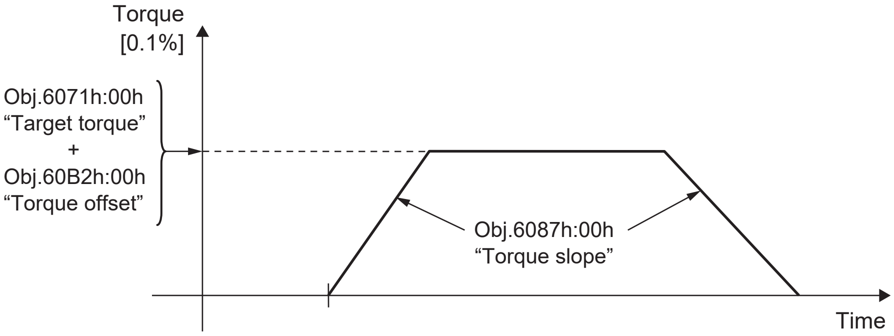
Obj.60B2h:00h “Torque offset”

Obj.6087h:00h “Torque slope”

The target torque is the sum of Obj.6071h:00h “Target torque” and Obj.60B2h:00h “Torque offset” .

Input the operation command update (transmission) after approximately 100 ms have elapsed since servo-on command (operation enabled command).

Obj.6077h:00h “Torque actual value” etc. is provided as monitoring information.



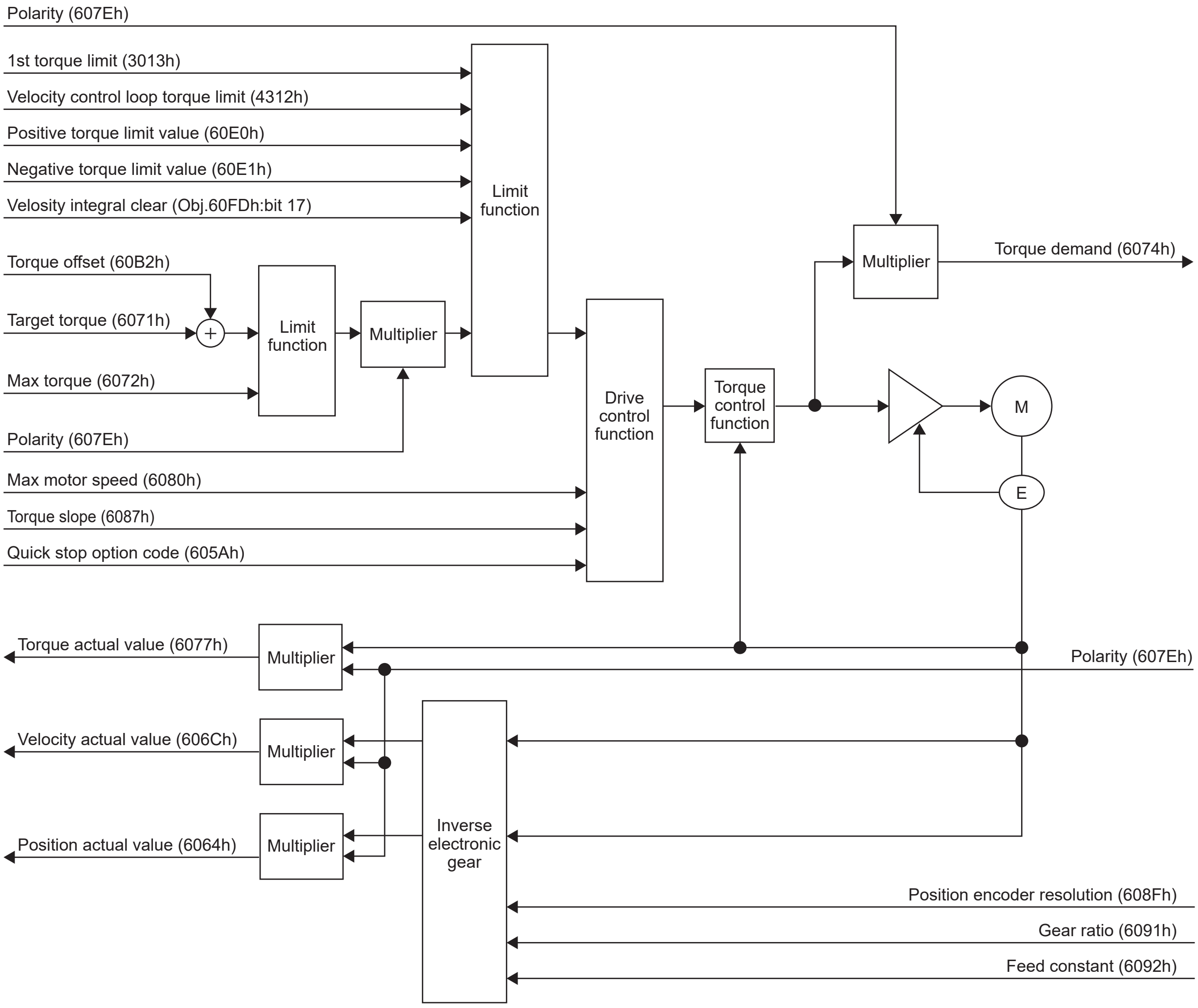
**— Precautions —**

- The sum of Obj.6071h:00h “Target torque” and Obj.60B2h:00h “Torque offset” is limited by the minimum value from among the following.
  - When Obj.3521h:00h “Selection of torque limit” = 5 is set:
    Obj.60E0h:00h “Positive torque limit value” , Obj.60E1h:00h “Negative torque limit value” , Obj.6072h:00h “Max torque”
  - When Obj.3521h:00h “Selection of torque limit” ≠ 5 is set:
    Obj.6072h:00h “Max torque” , Obj.3013h:00h “1st torque limit”
- Speed is limited by Obj.6080h:00h “Max motor speed” .
- Changes to these settings during operation are not reflected during that operation.

### 6.6.7.3 Cyclic Torque Control Mode (cst mode)

Cyclic torque control mode (cst mode) is a torque control mode in which the host device generates torque commands and updates (transmits) the command torque in a communication cycle.

Use in DC or SM2 synchronous mode.



#### 6.6.7.3.1 Objects Related to cst Control Mode (Command/Setting-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |

There are other related objects common to torque control. For details, see *"6.6.7.1 Torque Control Common Functions"* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 6071h | 00h | Target torque | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | tq<br>cst | Yes | A |
| 6072h | 00h | Max torque | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 607Fh | 00h | Max profile velocity | Command unit/s | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 6080h | 00h | Max motor speed | r/min | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | B |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes | A |
| 60E0h | 00h | Positive torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |
| 60E1h | 00h | Negative torque limit value | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | A |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |
| 607Bh | — | Position range limit | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |
| 608Fh | — | Position encoder resolution | — | — | — | — | — | ALL | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6091h | — | Gear ratio | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 6092h | — | Feed constant | — | — | — | — | — | ALL | — | |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P<br>H |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | B |
| 60C2h | — | Interpolation time period | — | — | — | — | — | ip<br>csp<br>csv<br>cst | — | — |
| | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ip<br>csp<br>csv<br>cst | No | X |
| | 01h | Interpolation time period value | — | 0 to 255 | U8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| | 02h | Interpolation time index | — | -128 to 63 | I8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| 60FEh | — | Digital outputs | — | — | — | — | — | ALL | — | — |
| | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |
| | 01h | Physical outputs | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |
| | 02h | Bit mask | — | 0 to 4294967295 | U32 | rw | RxPDO | ALL | Yes | A |

#### 6.6.7.3.1.1 Controlword (6040h) (Functions in cst Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6040h | 00h | Controlword | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |

- Sets control commands to the product, such as PDS state transitions.
  For the following setting values, the operation mode specific bit is not used cst control mode.

bit information details

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | | | | | (2) | (3) | (4) | (2) | | | (5) | (6) | (7) | (8) |
| | | | | | | (1) | | | (1) | (1) | (1) | | | | |

(1): reserved (not supported)
(2): operation mode specific (control mode dependent bit)
(3): halt
(4): fault reset
(5): enable operation
(6): quick stop
(7): enable voltage
(8): switch on

#### 6.6.7.3.1.2 Other

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |

- bit 12: Speed limit priority function during torque control
  - 0: Torque command priority
  - 1: Velocity limit priority

bit 12 = 1 (Speed limit priority) is only enabled for cyclic torque control mode (cst).

With velocity limit priority, if Obj.606Ch:00h “Velocity actual value” exceeds the velocity limit value (Obj.607Fh:00h “Max profile velocity” or Obj.6080h:00h “Max motor speed” ), the torque limit is disabled by Obj.60E0h:00h “Positive torque limit value” or Obj.60E1h:00h “Negative torque limit value” and the required torque is generated and controlled such that the velocity does not exceed the limit value. However, the maximum motor torque will be Obj.6072h:00h “Max torque” .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |

- bit 11: Condition setting for Obj.6041h: bit 12 “drive follows command value”
  - 0: Includes torque limit and speed limit (cst only)
  - 1: Does not include torque limit and speed limit (cst only)

#### 6.6.7.3.2 Objects Related to cst Control Mode (Monitoring-related)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

There are other related objects common to torque control. For details, see *"6.6.7.1 Torque Control Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6069h | 00h | Velocity sensor actual value | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 606Ch | 00h | Velocity actual value | Command unit/s | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6074h | 00h | Torque demand | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6075h | 00h | Motor rated current | mA | 0 to 4294967295 | U32 | rw | No | ALL | No | X |
| 6076h | 00h | Motor rated torque | mN･m | 0 to 4294967295 | U32 | ro | No | ALL | No | X |
| 6077h | 00h | Torque actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6078h | 00h | Current actual value | 0.1% | -32768 to 32767 | I16 | ro | TxPDO | ALL | No | X |
| 6079h | 00h | DC link circuit voltage | mV | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

There are other related objects commonly used for motion. For details, see *"6.6.8 Motion Common Functions"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

### 6.6.7.3.2.1 Statusword (6041h) (Functions in cst Control Mode)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6041h | 00h | Statusword | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Sets control commands to the product, such as PDS state transitions.
  For the following setting values, the operation mode specific bit is not used cst control mode.

bit information details

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | | (2) | | (3) | (2) | (4) | (1) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | | (1) | (13) | | (1) | | | | | | | | | | |

(1): reserved (not supported)
(2):operation mode specific (control mode dependent bit)
(3): internal limit active
(4): remote
(5): warning
(6): switch on disabled
(7): quick stop
(8): voltage enabled
(9): fault
(10): operation enabled
(11): switched on
(12): ready to switch on
(13): drive follows command value

## ■ Bit 13, 12, 10 (operation mode specific (control mode dependent bit)):

—: N/A

| bit | Name | Value | Definition |
|---|---|---|---|
| 10 | reserved | — | Not used |
| 12 | drive follows command value | 0 | Operation is not executed according to the target torque (*1) |
| | | 1 | Operation performed according to target torque (*1) |
| 13 | reserved | — | Not used |

*1 An “operation has been executed according to the target torque” means that all of the following conditions have been met.

If the condition is not met, the operation is not executed according to the target torque.

- PDS status is Operation enabled
- Not in a deceleration process (Halt, POT, NOT, Quickstop, Shutdown, Disable operation, Fault)
- Not in halt stop state
- POT is not detected during a positive direction operation command or NOT is not detected during a negative direction operation command
- Torque limit has not been triggered (when 3724h:bit 11 = 0)
- Velocity limit has not been triggered (when 3724h:bit 11 = 0)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| ● bit 11: Condition setting for Obj.6041h: bit 12 “drive follows command value”<br>0: Includes torque limit and speed limit (cst only)<br>1: Does not include torque limit and speed limit (cst only) | | | | | | | | | | |

### 6.6.7.3.3 Operation in cst Control Mode

In cyclic torque control mode, the motion profile (trajectory) is generated by the main device, not the sub device.

The target torque is the sum of Obj.6071h:00h “Target torque” and Obj.60B2h:00h “Torque offset” .

Input the operation command update (transmission) after approximately 100 ms have elapsed since servo-on command (operation enabled command).

Obj.60C2h: “Interpolation time period” indicates a cycle of updating two objects, Obj.6071h:00h “Target torque” and Obj.60B2h:00h “Torque offset” . This value is set to the same cycle as Obj.1C32h: “Sync manager 2 synchronization” : Obj.1C32h:02h “Cycle time” .

Obj.6077h:00h “Torque actual value” etc. is provided as monitoring information.

**— Precautions —**

- The sum of Obj.6071h:00h “Target torque” and Obj.60B2h:00h “Torque offset” is limited by the minimum value from among the following.
  - When Obj.3521h:00h “Selection of torque limit” = 5 is set:
    Obj.60E0h:00h “Positive torque limit value” , Obj.60E1h:00h “Negative torque limit value” , Obj.6072h:00h “Max torque”
  - When Obj.3521h:00h “Selection of torque limit” ≠ 5 is set:
    Obj.6072h:00h “Max torque” , Obj.3013h:00h “1st torque limit”
- Speed is limited by Obj.6080h:00h “Max motor speed” .

## 6.6.8 Motion Common Functions

### 6.6.8.1 Touch Probe Function (Position Latch Request, Release)

This function latches the feedback position by selecting a latch trigger signal from the external inputs (EXT1 and EXT2) or the Z-phase.

The Z-phase in semi-closed control can be selected from the position where the rotary encoder’s single-turn data is 0 or the Z-phase position of the external incremental scale.

The Z-phase in full-closed control is the Z-phase position of the external incremental scale.

Z-phase of external incremental scale can be selected even in semi-closed control. For details, see *“6.6.8.1.9 External Scale Z-phase Latch Function for Semi-closed Control”* .

Rising and falling edges can be set simultaneously for the same TouchProbe. The input ON and OFF widths of the latch trigger signal should be at least 2 ms each.

When Obj.3722h:00h “Communication function extended setup 1” :bit 4 = 1 and Obj.3697h:00h “Function expansion setup 3” :bit 11 = 1, the encoder and external scale feedback positions can be latched simultaneously.

By setting Obj.3697h:00h “Function expansion setup 3” :bit 13 = 1, Obj.60B9h:00h “Touch probe status” :bits 1, 2, 9, and 10 are reversed and output.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| ● bit 11: External scale position latch during semi-closed control<br>0: Disabled<br>1: Enabled<br>● bit 13: Touch probe latch completion status toggle output enabled<br>0: Disabled<br>1: Enabled | | | | | | | | | | |

**— Precautions —**

- When using an external input (EXT1 or EXT2) for the latch trigger signal, assign EXT1 or EXT2 to one of SI5, SI6, or SI7. Touch probing without assignment will result in Err88.3.0 “Improper operation error protection” .
- If the latch trigger signal is an external input (EXT1, EXT2), an acquisition error occurs. The speed near the latch trigger signal input should be as low as possible.
- When in full-closed control and the trigger selection is set to be Z-phase when using the absolute scale, Err88.3.0 “Improper operation error protection” will be triggered.
- When Z-phase is selected for trigger selection, do not select the falling edge. Operation cannot be guaranteed with the above settings.
- The touch probe function is disabled (canceled) in the following cases.

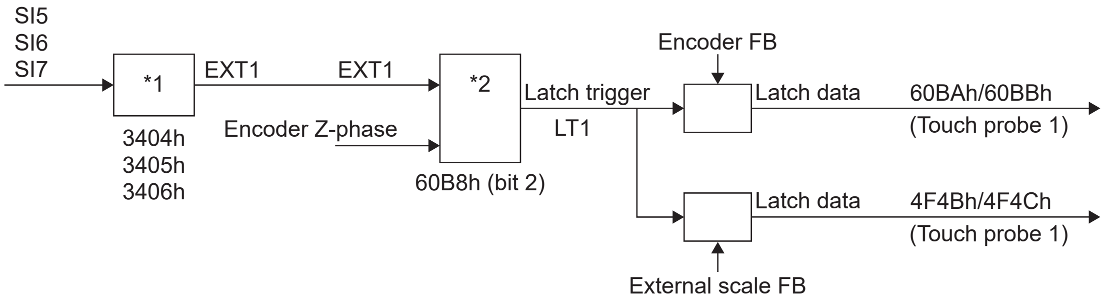
  (The value of Obj.60B9h:00h “Touch probe status” is cleared to 0)

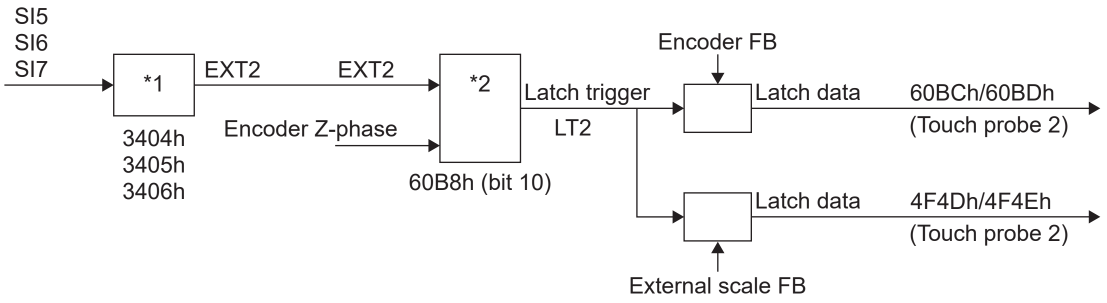
  1 When ESM state is Init

  2 When switched to hm mode
- Do not perform multi-turn data clear, trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING, or Config execution from Set-up Support Software (PANATERM ver.7) while TouchProbe is running. Operation is not guaranteed when the above is implemented.

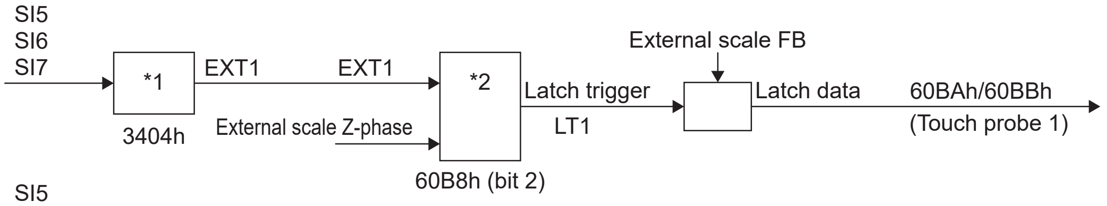
### 6.6.8.1.1 Touch Probe Function Configuration

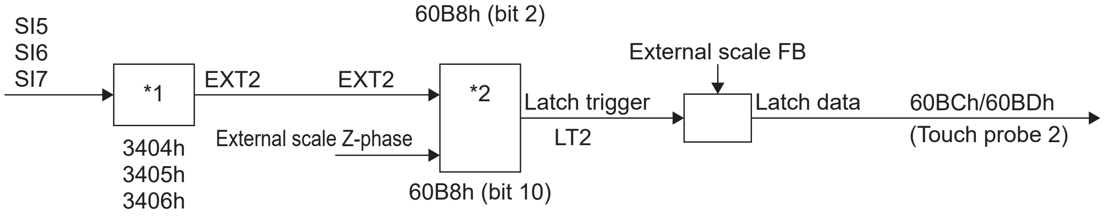
- When using semi-closed control





- When using full-closed control





*1 The table below shows the objects corresponding to the latch correction terminals and the external inputs that can be assigned.

| Latch correction terminal and corresponding object | Setup value | Assignment |
|---|---|---|
| SI5: Obj.3404h:00h “SI5 input selection”<br>SI6: Obj.3405h:00h “SI6 input selection”<br>SI7: Obj.3406h:00h “SI7 input selection” | 00202020h | Select EXT1 a-contact |
| | 00A0A0A0h | Select EXT1 b-contact |
| | 00212121h | Select EXT2 a-contact |
| | 00A1A1A1h | Select EXT2 b-contact |

*2 Obj.60B8h:00h “Touch probe function” :bit 10 and bit 2 are used to select the latch trigger signal.

- bit 10
  - 0: LT2 = EXT2
  - 1: LT2 = Z-phase
- bit 2
  - 0: LT1 = EXT1
  - 1: LT1 = Z-phase

* Obj.60B8h:00h “Touch probe function”

Obj.60BAh:00h “Touch probe 1 positive edge”

Obj.60BBh:00h “Touch probe 1 negative edge”

Obj.60BCh:00h “Touch probe 2 positive edge”

Obj.60BDh:00h “Touch probe 2 negative edge”

Obj.4F4Bh:00h “Touch probe external scale 1 positive edge”

Obj.4F4Ch:00h “Touch probe external scale 1 negative edge”

Obj.4F4Dh:00h “Touch probe external scale 2 positive edge”

Obj.4F4Eh:00h “Touch probe external scale 2 negative edge”

- For a configuration that uses the external scale Z-phase as the latch trigger during semi-closed control, see *“6.6.8.1.9 External Scale Z-phase Latch Function for Semi-closed Control”* .

The table below shows what is latched by the touch probe in each mode.

—: No applicable conditions

| Control mode | External scale position information Monitor function | Function expansion setup 3 (External scale position latch) | Latch target object | |
|---|---|---|---|---|
| | | | Obj.60BAh,<br>Obj.60BBh,<br>Obj.60BCh,<br>Obj.60BDh | Obj.4F4Bh,<br>Obj.4F4Ch,<br>Obj.4F4Dh,<br>Obj.4F4Eh |
| When using semi-closed control | Enable (Obj.3722h:00h “Communication function extended setup 1” :bit 4 = 1) | Enable (Obj.3697h:00h “Function expansion setup 3” :bit 11 = 1) | Encoder FB | External scale FB |
| | | Disable (Obj.3697h:00h “Function expansion setup 3” :bit 11 = 0) | | — |
| | Disable (Obj.3722h:00h “Communication function extended setup 1” :bit 4 = 0) | — | | |
| When using full-closed control | — | — | External scale FB | |

### 6.6.8.1.2 Touch Probe Related Objects

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4304h | 00h | Touch probe function expansion setup | — | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | B |
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F48h | 00h | External scale pulse total | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F4Bh | 00h | Touch probe external scale 1 positive edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F4Ch | 00h | Touch probe external scale 1 negative edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F4Dh | 00h | Touch probe external scale 2 positive edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F4Eh | 00h | Touch probe external scale 2 negative edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 3697h | 00h | Function expansion setup 3 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| 3709h | 00h | Correction time of latch delay 1 | 25 ns | -2000 to 2000 | I16 | rw | No | ALL | Yes | B |
| 3722h | 00h | Communication function extended setup 1 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | R |
| 3792h | 00h | Correction time of latch delay 2 | 25 ns | -2000 to 2000 | I16 | rw | No | ALL | Yes | B |
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |

### 6.6.8.1.3 Touch probe function (60B8h)

Basic object used to start touch probe operation and various settings.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60B8h | 00h | Touch probe function | — | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| | ● Configure settings for the Touch probe function. | | | | | | | | | |

Supported bit description

—: N/A

| bit | value | Note | |
|---|---|---|---|
| 0 | 0 | Switch off touch probe 1 | Touch Probe 1<br>Execute, stop |
| | 1 | Enable touch probe 1 | |
| 1 | 0 | Trigger first event | Touch Probe 1<br>Event mode selection |
| | 1 | Continuous | |
| 2 | 0 | Trigger with touch probe 1 input | Touch Probe 1<br>Trigger select<br>(External input, Z-phase) |
| | 1 | Trigger with zero impulse signal of position encoder | |
| 3 | — | Reserved | Not used |
| 4 | 0 | Switch off sampling at positive edge of touch probe 1 | Touch Probe 1 (*1) (*3)<br>Rising edge select |
| | 1 | Enable sampling at positive edge of touch probe 1 | |
| 5 | 0 | Switch off sampling at negative edge of touch probe 1 | Touch Probe 1 (*1) (*2) (*3)<br>Falling edge select |
| | 1 | Enable sampling at negative edge of touch probe 1 | |
| 7 to 6 | — | Not Supported | Not used |
| 8 | 0 | Switch off touch probe 2 | Touch Probe 2<br>Execute, stop |
| | 1 | Enable touch probe 2 | |
| 9 | 0 | Trigger first event | Touch Probe 2<br>Event mode selection<br>(Single, continuous) |
| | 1 | Continuous | |
| 10 | 0 | Trigger with touch probe 2 input | Touch Probe 2<br>Trigger select<br>(External input, Z-phase) |
| | 1 | Trigger with zero impulse signal of position encoder | |
| 11 | — | Reserved | Not used |
| 12 | 0 | Switch off sampling at positive edge of touch probe 2 | Touch Probe 2 (*1) (*3)<br>Rising edge select |
| | 1 | Enable sampling at positive edge of touch probe 2 | |
| 13 | 0 | Switch off sampling at negative edge of touch probe 2 | Touch Probe 2 (*1) (*2) (*3)<br>Falling edge select |
| | 1 | Enable sampling at negative edge of touch probe 2 | |
| 14 | — | Not Supported | Not used |
| 15 | 0 | Switch off external scale position monitor value 0 clear | External scale monitor value<br>0 clear enable, disable (*4) (*5) |
| | 1 | Enable external scale position monitor value 0 clear | |

*1 Only when external input is selected for trigger selection, rising and falling edges can be set simultaneously in the same TouchProbe.

In that case, both edges are used as trigger signals.

*2 When Z-phase is selected for trigger selection, do not select the falling edge.

Operation cannot be guaranteed with the above settings.

*3 The rising edge indicates when the logic state of the target signal changes from OFF (inactive) to ON (active), and the falling edge indicates when the logic state of the target signal changes from ON to OFF.

*4 When external scale monitor value 0 clear is enabled, monitor values Obj.4F0Dh:00h “External scale position” and Obj.4F48h:00h “External scale pulse total” are always set to 0.

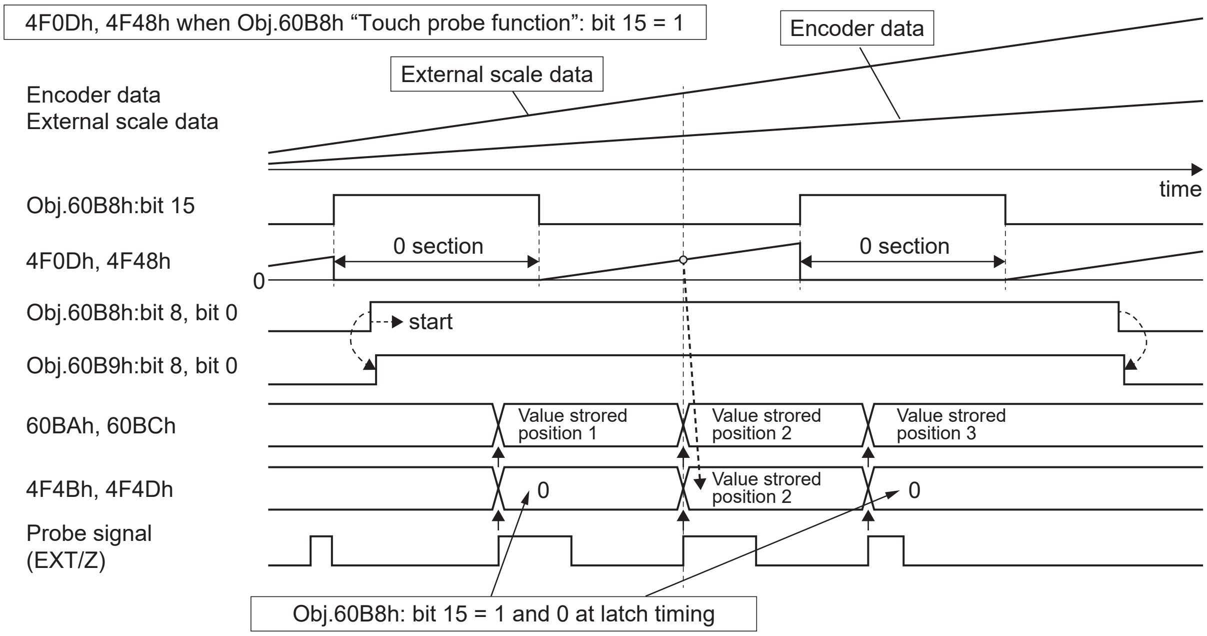
If latched at this time, Obj.4F4Bh to Obj.4F4Eh will be 0.

The amount of scale position change from the timing when 0 clear is set to disabled is added to the above monitor value.

After power reset, the values of Obj.4F0Dh:00h “External scale position” and Obj.4F48h:00h “External scale pulse total” are set to the external scale pulse sum read from the external scale.

*5 This function (external scale monitor value 0 clear enable/disable) is not a function specified in the ETG standard.

During semi-closed control, it is possible to simultaneously latch encoder feedback (Obj.60BAh:00h “Touch probe 1 positive edge” , Obj.60BBh:00h “Touch probe 1 negative edge” , Obj.60BCh:00h “Touch probe 2 positive edge” , Obj.60BDh:00h “Touch probe 2 negative edge” ) and external scale feedback (Obj.4F4Bh:00h “Touch probe external scale 1 positive edge” , Obj.4F4Ch:00h “Touch probe external scale 1 negative edge” , Obj.4F4Dh:00h “Touch probe external scale 2 positive edge” , Obj.4F4Eh:00h “Touch probe external scale 2 negative edge” ) with probe signal (EXT, Z).



### 6.6.8.1.4 Touch probe status (60B9h)

Displays the status of the touch probe operation.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60B9h | 00h | Touch probe status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | ● Displays the status of the touch probe function. | | | | | | | | | |

Supported bit description

—: N/A

| bit | value | Note | |
|---|---|---|---|
| 0 | 0 | Touch probe 1 is switch off | Touch probe 1 operation stop |
| | 1 | Touch probe 1 is enabled | Touch probe 1 in operation |
| 1 | 0 | Touch probe 1 no positive edge value stored | Rising edge touch probe 1 Not complete state |
| | 1 | Touch probe 1 positive edge value stored | Rising edge touch probe 1 completed state |
| 2 | 0 | Touch probe 1 no negative edge value stored | Falling edge touch probe 1 Not complete state |
| | 1 | Touch probe 1 negative edge value stored | Falling edge touch probe 1 complete state |
| 5 to 3 | — | Reserved | Not used |
| 7 to 6 | — | Not Supported | Not used |
| 8 | 0 | Touch probe 2 is switch off | Touch probe 2 operation stop |
| | 1 | Touch probe 2 is enabled | Touch probe 2 in operation |
| 9 | 0 | Touch probe 2 no positive edge value stored | Rising edge touch probe 2 Not complete state |
| | 1 | Touch probe 2 positive edge value stored | Rising edge touch probe 2 completed state |
| 10 | 0 | Touch probe 2 no negative edge value stored | Falling edge touch probe 2 Not complete state |
| | 1 | Touch probe 2 negative edge value stored | Falling edge touch probe 2 complete state |
| 13 to 11 | — | Reserved | Not used |
| 15 to 14 | — | Not Supported | Not used |

* By setting Obj.3697h:00h “Function expansion setup 3” :bit 13 = 1, Obj.60B9h:00h “Touch probe status” :bits 1, 2, 9, and 10 are reversed and output (toggled output).

### 6.6.8.1.5 Touch Probe Position

Touch probe position displays the captured latch position.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60BAh | 00h | Touch probe 1 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The rising edge of touch probe 1 displays the latched position. | | | | | | | | | |
| 60BBh | 00h | Touch probe 1 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The falling edge of touch probe 1 displays the latched position. | | | | | | | | | |
| 60BCh | 00h | Touch probe 2 positive edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The rising edge of touch probe 2 displays the latched position. | | | | | | | | | |
| 60BDh | 00h | Touch probe 2 negative edge | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The falling edge of touch probe 2 displays the latched position. | | | | | | | | | |

Touch probe external scale position displays the captured external scale latch position.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F4Bh | 00h | Touch probe external scale 1 positive edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The rising edge of touch probe 1 displays the latched external scale feedback position.<br>Updates when the external scale latch condition is met during semi-closed control.<br>The value does not change after homing. | | | | | | | | | |
| 4F4Ch | 00h | Touch probe external scale 1 negative edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The falling edge of touch probe 1 displays the latched external scale feedback position.<br>Updates when the external scale latch condition is met during semi-closed control.<br>The value does not change after homing. | | | | | | | | | |
| 4F4Dh | 00h | Touch probe external scale 2 positive edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The rising edge of touch probe 2 displays the latched external scale feedback position.<br>Updates when the external scale latch condition is met during semi-closed control.<br>The value does not change after homing. | | | | | | | | | |
| 4F4Eh | 00h | Touch probe external scale 2 negative edge | Pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● The falling edge of touch probe 2 displays the latched external scale feedback position.<br>Updates when the external scale latch condition is met during semi-closed control.<br>The value does not change after homing. | | | | | | | | | |

### 6.6.8.1.6 Activation of Touch Probe Operation

When Obj.60B8h:00h “Touch probe function” :bit 8, bit 0 “Touch probe execute, stop” changes from 0 (stop) to 1 (start), the various setting conditions (Obj.60B8h:bits 15 to 9, bits 7 to 1) are taken in, touch probe operation is started. To enable changes to various setting conditions, set bit 8 and bit 0 back to 0 (stop) and then set bit 8 and bit 0 to 1 (start) again.

#### 6.6.8.1.7 Touch Probe Event Mode

With Obj.60B8h:00h “Touch probe function” :bit 9, bit 1 “Event mode selection”, 0 “Trigger first event mode”, -1 “Continuous mode” can be selected.

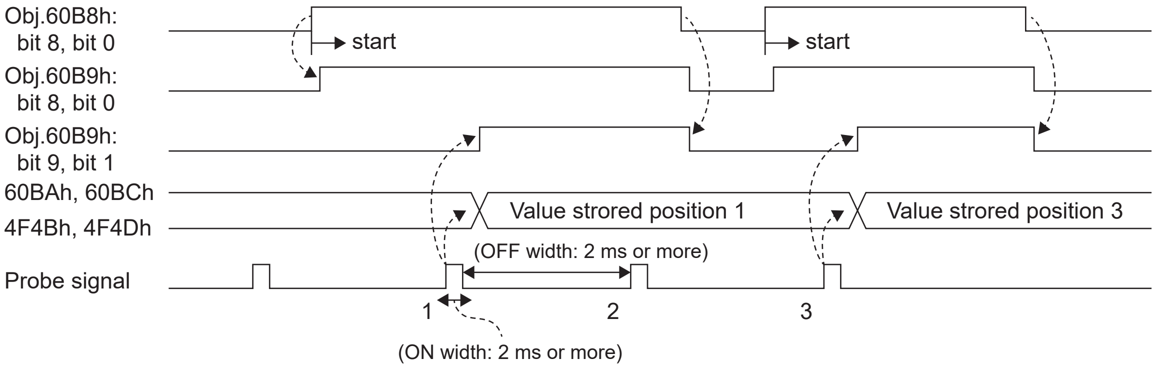
### ■ Trigger first event mode

(Obj.60B8h:00h “Touch probe function” :bit 9 = 0, bit 1 = 0)

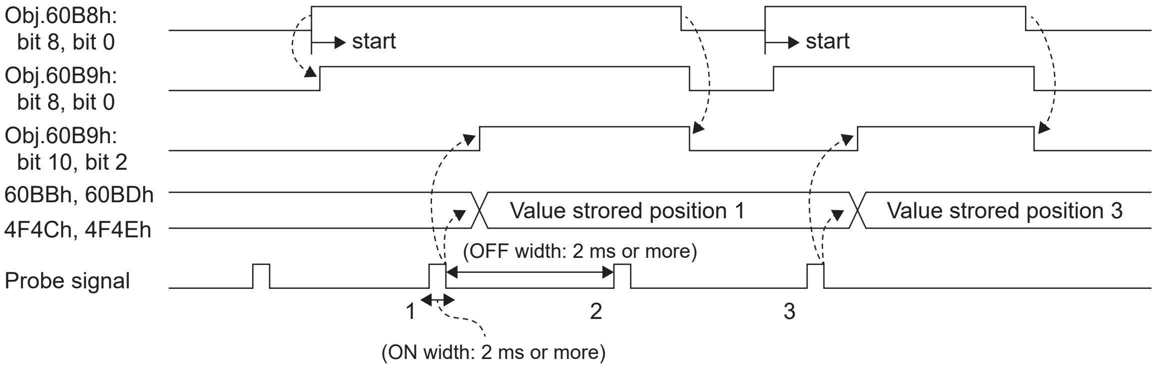
This mode latches only at the first trigger signal after startup.

When both rising and falling edges are set to enable, latch is performed once each at the rising and falling edges of the trigger signal. Any order of edges is acceptable. To capture it again, the touch probe must be restarted.

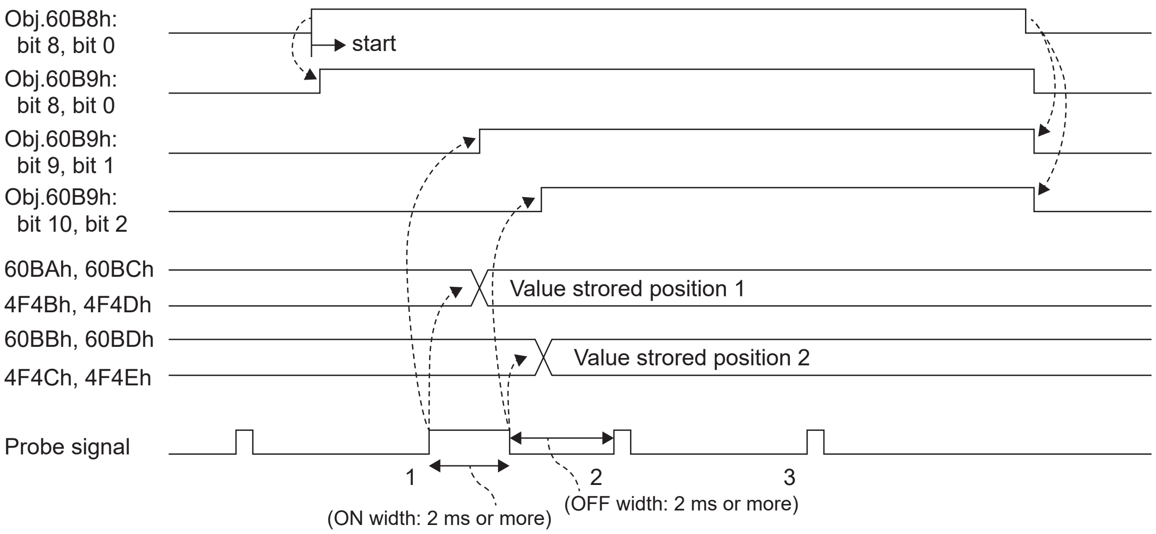
- **Positive edge**



- **Negative edge**



- **Positive edge and Negative edge**



## ■ Continuous mode

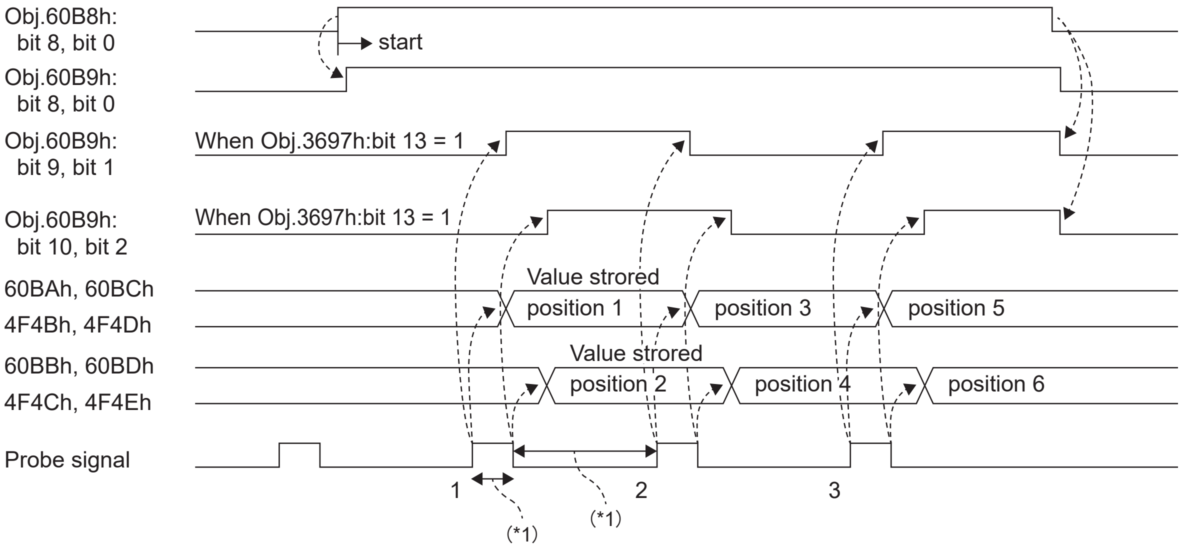
(Obj.60B8h:00h “Touch probe function” :bit 9 = 1, bit 1 = 1)

This mode latches every time a trigger signal is detected after startup.

The captured value is retained until the next probe signal.

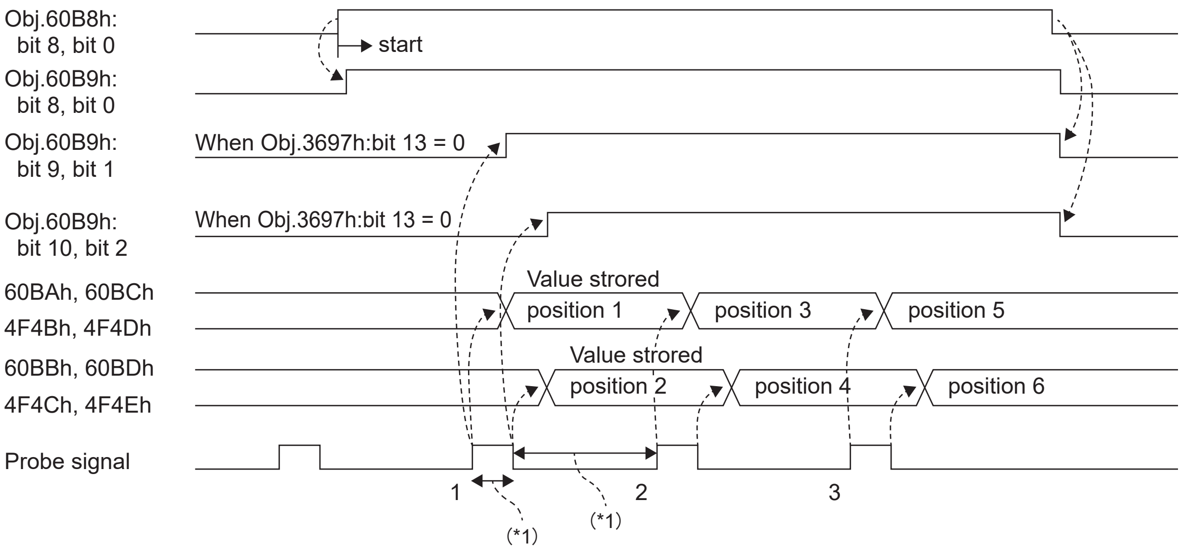
Setting Obj.3697h:00h “Function expansion setup 3” :bit 13 = 1 reverses bits 1, 2, 9, and 10 of Obj.60B9h:00h “Touch probe status” and outputs them (toggle output) each time they are latched.

- **Positive edge, Negative edge Obj.3697h:bit 13 = 1**



*1 The ON and OFF widths should be at least 2 ms each.

- **Positive edge, Negative edge Obj.3697h:bit 13 = 0**



*1 The ON and OFF widths should be at least 2 ms each.

#### 6.6.8.1.8 Latch Position Detection Delay Compensation Function

The latch position detection delay compensation function allows setting of a compensation time for the delay in latch trigger signal detection.

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>3709h</td><td>00h</td><td>Correction time of latch delay 1</td><td>25 ns</td><td>-2000 to 2000</td><td>I16</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">● Sets the compensation time for the delay in latch trigger signal detection.<br>This object allows switching of compensation of the latch position detection delay amount at Obj.3724h:00h “Communication function extended setup 3” :bit 5.<br>bit 5 = 0: Reflected in the detection delay amount for both rising edge detection and falling edge detection.<br>bit 5 = 1: Reflected in the detection delay amount for rising edge detection.<br>Notes<br>● Edge detection signal states refer to the following.<br>Rising edge: Isolator OFF to ON<br>Falling edge: Isolator ON to OFF</td></tr>
<tr><td>3724h</td><td>00h</td><td>Communication function extended setup 3</td><td>Command unit</td><td>-32768 to 32767</td><td>I16</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>Yes</td><td>C</td></tr>
<tr><td colspan="11">● bit 5: Latch position detection delay compensation function switching<br>0: Sets the compensation time for the amount of delay of the rising and falling edge to be shared with Obj.3709h:00h “Correction time of latch delay 1”<br>1: Sets rising and falling edge delay compensation times separately with Obj.3709h:00h “Correction time of latch delay 1” and Obj.3792h:00h “Correction time of latch delay 2”</td></tr>
<tr><td>3792h</td><td>00h</td><td>Correction time of latch delay 2</td><td>25 ns</td><td>-2000 to 2000</td><td>I16</td><td>ro</td><td>TxPDO</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">● Sets the compensation time for the delay in latch trigger signal detection.<br>This object allows switching of compensation of the latch position detection delay amount at Obj.3724h:00h “Communication function extended setup 3” : bit 5.<br>bit 5 = 0: Disabled<br>bit 5 = 1: Reflected in the detection delay amount for falling edge detection.<br>Notes<br>● Edge detection signal states refer to the following.<br>Rising edge: Isolator OFF to ON<br>Falling edge: Isolator ON to OFF</td></tr>
</table>

**— Precautions —**

- The amount of delay for the latch trigger signal detection may vary depending on the operating environment or aging deterioration. Set the delay correction time as necessary if latch precision is required.

### 6.6.8.1.9 External Scale Z-phase Latch Function for Semi-closed Control

During semi-closed control, the external scale position latched by the Z-phase of the external incremental scale can be acquired.

To enable this function, the external scale position information monitor function must be enabled (Obj.3722h:00h “Communication function extended setup 1” :bit 4 = 1) and the external scale position latch must be enabled (Obj.3697h:00h “Function expansion setup 3” :bit 11 = 1).

To use this function when the external scale is A/B-phase output type, make the following settings. If a touch probe operation is activated with a different setting, Err91.3.☐ “Command error protection2” will be triggered.

- Set Obj.4304h:00h “Touch probe function expansion setup” :bit 8 and bit 0 to the same value.
- If Obj.4304h:00h “Touch probe function expansion setup” :bit 8 and bit 0 are set to 1, Obj.60B8h:00h “Touch probe function” :bit 10 and bit 2 are set to 1.

If either Obj.4304h:00h “Touch probe function expansion setup” :bit 8 or bit 0 or both are set to 1 and homing is started, Err91.3.☐ will be triggered.

When the external scale feedback position is stored in the following objects with Obj.4304h:00h “Touch probe function expansion setup” :bit 9 and bit 1, the unit of each object is pulse (external scale).

- Obj.60BAh:00h “Touch probe 1 positive edge” and Obj.60BBh:00h “Touch probe 1 negative edge”
- Obj.60BCh:00h “Touch probe 2 positive edge” and Obj.60BDh:00h “Touch probe 2 negative edge”

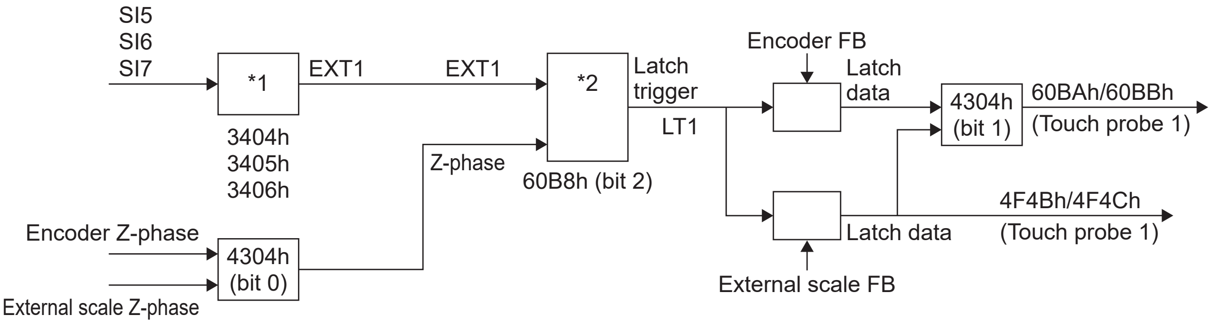
Touch probe function expansion setup object

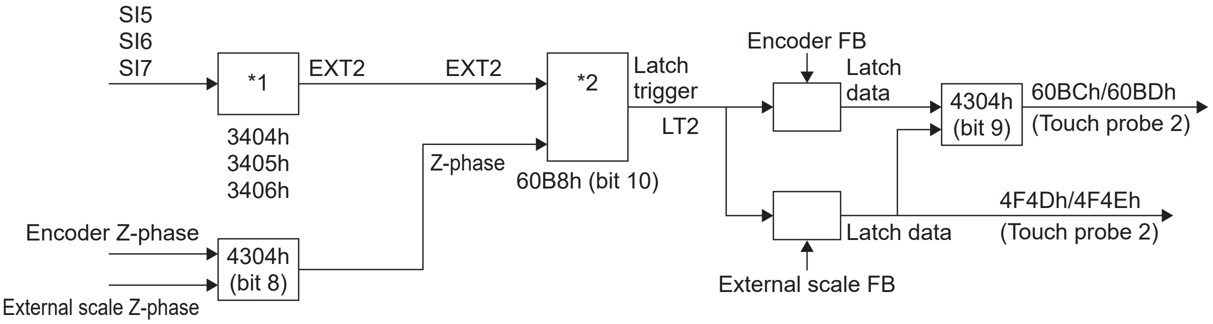
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4304h | 00h | Touch probe function expansion setup | — | 0 to 65535 | U16 | rw | RxPDO | ALL | Yes | B |

| bit | Value | Note | |
|---|---|---|---|
| 0 | 0 | Encoder Z-phase | Touch probe 1<br>External scale position latch Z-phase switching in semi-closed control<br>**— Precautions —**<br>● bit 0 is enabled only when using semi-closed control. |
| | 1 | External scale Z-phase | |
| 1 | 0 | Encoder FB | Touch probe 1<br>Change storage location of external scale feedback position in semi-closed control<br>**— Precautions —**<br>● bit 1 is enabled only when using semi-closed control. |
| | 1 | External scale FB | |
| 2 to 7 | Fixed to 0 | Manufacturer use | |
| 8 | 0 | Encoder Z-phase | Touch probe 2<br>External scale position latch Z-phase switching in semi-closed control<br>**— Precautions —**<br>● bit 8 is enabled only when using semi-closed control. |
| | 1 | External scale Z-phase | |
| 9 | 0 | Encoder FB | Touch probe 2<br>Change storage location of external scale feedback position in semi-closed control<br>**— Precautions —**<br>● bit 9 is enabled only when using semi-closed control. |
| | 1 | External scale FB | |
| 10 to 15 | Fixed to 0 | Manufacturer use | |

- When using semi-closed control





*1 The table below shows the objects corresponding to the latch correction terminals and the external inputs that can be assigned.

| Latch correction terminal and corresponding object | Setup value | Assignment |
|---|---|---|
| SI5: Obj.3404h:00h “SI5 input selection”<br>SI6: Obj.3405h:00h “SI6 input selection”<br>SI7: Obj.3406h:00h “SI7 input selection” | 00202020h | Select EXT1 a-contact |
| | 00A0A0A0h | Select EXT1 b-contact |
| | 00212121h | Select EXT2 a-contact |
| | 00A1A1A1h | Select EXT2 b-contact |

*2 Obj.60B8h:00h “Touch probe function” :bit 10 and bit 2 are used to select the latch trigger signal.

- bit 10
  - 0: LT2 = EXT2
  - 1: LT2 = Z-phase
- bit 2
  - 0: LT1 = EXT1
  - 1: LT1 = Z-phase

* Obj.60B8h:00h “Touch probe function”

Obj.60BAh:00h “Touch probe 1 positive edge”

Obj.60BBh:00h “Touch probe 1 negative edge”

Obj.60BCh:00h “Touch probe 2 positive edge”

Obj.60BDh:00h “Touch probe 2 negative edge”

Obj.4304h:00h “Touch probe function expansion setup”

Obj.4F4Bh:00h “Touch probe external scale 1 positive edge”

Obj.4F4Ch:00h “Touch probe external scale 1 negative edge”

Obj.4F4Dh:00h “Touch probe external scale 2 positive edge”

Obj.4F4Eh:00h “Touch probe external scale 2 negative edge”

### 6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)

Sets the motor deceleration to stop method in the event of a main power failure or alarm when PDS is in the operation enabled state (servo-on state).

Uses the deceleration function (optional code) defined in CoE (CiA402) and the deceleration function on the servo (this product) side (dynamic brake stop, free-run stop, emergency stop) in combination.

The deceleration settings must be changed from their factory default values to values appropriate for the environment in which the device is used. For the factory default values of each parameter and EtherCAT object, see *"6.2 Object Dictionary List"* .

List of PDS option codes

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6007h | 00h | Abort connection option code | — | 0 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |

Related object list

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| | ● Sets the profile deceleration.<br>● In cyclic position control mode (csp) and cyclic velocity control mode (csv), this is enabled only during deceleration stop sequences.<br>● If set to 0, treated as 1 by internal processing. | | | | | | | | | |
| 6085h | 00h | Quick stop deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>ip<br>pv<br>hm<br>csp<br>csv | Yes | A |
| | ● If Obj.605Ah:00h "Quick stop option code" is 2 or 6, sets the deceleration parameter value used for motor deceleration to stop during Quick stop.<br>● It is also used when Obj.605Dh:00h "Halt option code" and Obj.605Eh:00h "Fault reaction option code" are 2.<br>● If set to 0, treated as 1 by internal processing. | | | | | | | | | |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| | ● Sets the parameter value to give a gradient to the torque command.<br>● In cyclic torque control mode (cst), this is enabled only during deceleration to stop sequences.<br>● If set to 0, treated as 1 by internal processing. | | | | | | | | | |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>609Ah</td><td>00h</td><td>Homing acceleration</td><td>Command unit/s<sup>2</sup></td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>hm</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">
<ul>
<li>Sets acceleration and deceleration in homing position control mode (hm).</li>
<li>The deceleration in homing position control mode (hm) is also used by this object.</li>
<li>At the final stop of each homing method (when the home position is detected), this object’s setup value is not used and the servo lock stops.</li>
<li>If set to 0, treated as 1 by internal processing.</li>
</ul>
</td></tr>
<tr><td>60C6h</td><td>00h</td><td>Max deceleration</td><td>Command unit/s<sup>2</sup></td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>pp<br>hm<br>pv<br>ip</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">
<ul>
<li>Sets the maximum deceleration.</li>
<li>If set to 0, treated as 1 by internal processing.</li>
</ul>
</td></tr>
<tr><td>3506h</td><td>00h</td><td>Sequence at Servo-Off</td><td>—</td><td>0 to 9</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">
<ul>
<li>Sets the status of the following (1) through (5) during deceleration and after stopping.</li>
</ul>
<table>
<tr><td>(1)</td><td>Obj.605Ah:00h “Quick stop option code” = 0</td><td>When Quick stop is received</td></tr>
<tr><td>(2)</td><td>Obj.605Bh:00h “Shutdown option code” = 0</td><td>When Shutdown or Disable voltage is received</td></tr>
<tr><td>(3)</td><td>Obj.605Ch:00h “Disable operation option code” = 0</td><td>When Disable operation is received</td></tr>
<tr><td>(4)</td><td>Obj.6007h:00h “Abort connection option code” = 2<br>Obj.605Bh = 0</td><td>When main power is turned off</td></tr>
<tr><td>(5)</td><td>Obj.6007h:00h “Abort connection option code” = 3<br>Obj.605Ah = 0</td><td>When main power is turned off</td></tr>
</table>
</td></tr>
<tr><td>3510h</td><td>00h</td><td>Sequence at alarm</td><td>—</td><td>0 to 7</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">
<ul>
<li>Sets the status during deceleration and after stopping when an alarm other than Err80.□.□, Err81.□.□, Err85.0.0 to Err85.3.0, and Err88.0.0 to Err88.3.0 occurs.</li>
</ul>
</td></tr>
</table>

If another deceleration factor (such as an alarm) occurs during deceleration, deceleration will occur according to the following priority order. Put simply, the deceleration function on the servo (this product) side has priority.

When a factor with a higher priority occurs, the deceleration process switches to the higher priority deceleration process even during deceleration operation. (*3)

If a factor with a lower priority occurs, the previously received deceleration operation is retained.

(Example) If an alarm occurs during deceleration at Obj.605Ah:00h “Quick stop option code” , the deceleration rate switches to that of Obj.605Eh:00h “Fault reaction option code” from the time the alarm occurs.

<Highest Priority> • Servo (this product) side deceleration (during alarm)
↓ • STO deceleration (*4)
↓ • Servo (this product) side deceleration (when servo or main power are off)
↓ • Servo (this product) side deceleration (when drive is disabled) (*6)
↓ • Fault deceleration
↓ • Retracting operation (*5)
↓ • Other CoE (CiA402) side deceleration (*1) (*3)
↓ • Limit system deceleration (*2)
↓ • Halt deceleration
<Lowest Priority> • Normal deceleration

*1 Refers to deceleration by Quick stop, Shutdown, and Disable operation.

*2 This refers to the over-travel inhibit input (POT, NOT) and deceleration by software limits.

*3 If 0 (servo side deceleration) is selected for the option code for other CoE side deceleration, the priority is the same as that of the servo side deceleration (servo-off). However, even in this case, if other CoE-side deceleration factors occur during fault deceleration, fault deceleration continues instead of servo-side deceleration.

*4 STO deceleration is deceleration with the STO function and is set in Obj.3510h.

*5 During the retracting operation, the PDS state becomes “Fault reaction active” and PDS state transition initiated by user command cannot be performed. Therefore, even if the servo (this product) decelerates (when the servo is off), the retracting operation continues regardless of the priority level.

*6 If the servo is turned off during deceleration by the servo (this product) side deceleration (when drive is disabled), the servo (this product) side deceleration (when drive is disabled) is retained.

### 6.6.8.2.1 Abort connection option code (6007h)

Sets the motor deceleration stop method when the main power shuts off.

The operation sequence when the main power shuts off depends on the combination of Obj.6007h:00h "Abort connection option code" , Obj.3508h:00h "L/V trip selection upon main power off" , Obj.3509h:00h "Detection time of main power off" , etc.

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>6007h</td><td>00h</td><td>Abort connection option code</td><td>—</td><td>0 to 3</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the deceleration stop sequence to be executed 70 ms after the main power shuts off until the main power off detection time set by Obj.3509h:00h "Detection time of main power off" in the event the main power shuts off physically.<br>When Obj.3509h:00h "Detection time of main power off" = 2000, only the deceleration stop sequence set by this object is executed.<br>Settings other than the following values are prohibited.<br>0: No action<br>1: Fault signal (decelerates according to Obj.605Eh:00h "Fault reaction option code" )<br>2: Disable voltage command (decelerates according to Obj.605Bh:00h "Shutdown option code" )<br>3: Quick stop command (decelerates according to Obj.605Ah:00h "Quick stop option code" )</td></tr>
<tr><td>3507h</td><td>00h</td><td>Sequence upon main power off</td><td>—</td><td>0 to 9</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">● Sets the deceleration mode (sequence upon main power off) for the servo side (this product).<br>Sets the status during deceleration and after stopping when Obj.3508h:00h "L/V trip selection upon main power off" : bit 0 is "0", Obj.3509h:00h "Detection time of main power off" is not "2000", and the main power is shut off.</td></tr>
<tr><td>3508h</td><td>00h</td><td>L/V trip selection upon main power off</td><td>—</td><td>0 to 3</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>B</td></tr>
<tr><td colspan="11">● Select whether to trip LV or servo-off when there is a main power supply alarm.<br>bit 0 = 0: Servo-off according to the settings for Obj.3507h:00h "Sequence upon main power off" or Obj.6007h:00h "Abort connection option code" .<br>bit 0 = 1: Err13.1.0 "Main power supply undervoltage protection (AC interrupt detection)" detected<br>bit 1 = 0: Main power off warning detected only when servo-on<br>bit 1 = 1: Main power off warning always detected</td></tr>
<tr><td>3509h</td><td>00h</td><td>Detection time of main power off</td><td>ms</td><td>20 to 2000</td><td>I16</td><td>rw</td><td>No</td><td>ALL</td><td>Yes</td><td>C</td></tr>
<tr><td colspan="11">● Obj.3507h:00h "Sequence upon main power off" sets the start time for deceleration processing.<br>Obj.3507h:00h "Sequence upon main power off" disables deceleration processing when the setting value is 2000.<br>**— Precautions —**<br>● Setting "2000" does not disable the deceleration process for the CoE (CiA402) side.<br>● Resolution is set to 2 ms. For example, when the set value = 99, processing is performed at 100 ms.</td></tr>
</table>

There are other related objects. For details, see the first part of *"6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)"* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6085h | 00h | Quick stop deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| 60C6h | 00h | Max deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 3506h | 00h | Sequence at Servo-Off | — | 0 to 9 | I16 | rw | No | ALL | Yes | B |
| 3510h | 00h | Sequence at alarm | — | 0 to 7 | I16 | rw | No | ALL | Yes | B |

The table below shows the operation sequence depending on the combination of objects.

In principle, the deceleration function defined by CoE (CiA402) remains in effect until the deceleration function on the servo-side (this product) is activated when an interruption to the main power supply AC (between L1 and L3) is detected.

If set to “No action” by Obj.6007h:00h “Abort connection option code” = 0, the deceleration function on the servo-side (this product) is activated rather than the CoE (CiA402) deceleration function.

When the voltage across P-N drops, Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” is triggered with the highest priority. Operation is initiated in accordance with Obj.3510h:00h “Sequence at alarm” .

### When Obj.3509h:00h “Detection time of main power off” = 2000 (when main power AC off detection is disabled)

—: No applicable conditions

| Status | Obj.6007h:00h “Abort connection option code” Setup value | Target option code Setup value | Deceleration method |
|---|---|---|---|
| When voltage across P-N drops | — | — | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” is triggered |
| When main power AC (between L1 and L3) is off | 0 (No action) | — | Operational status is retained |
| | 1 (Fault signal) | Obj.605Eh:00h “Fault reaction option code” = 0 | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered |

| Status | Obj.6007h:00h “Abort connection option code” Setup value | Target option code Setup value | Deceleration method |
|---|---|---|---|
| When main power AC (between L1 and L3) is off | 1 (Fault signal) | Obj.605Eh:00h “Fault reaction option code” = Other than 0 | Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered after deceleration according to Obj.605Eh:00h “Fault reaction option code” |
| | 2 (Disable voltage command) | Obj.605Bh:00h “Shutdown option code” = 0 | Decelerates according to Obj.3506h:00h “Sequence at Servo-Off” |
| | | Obj.605Bh:00h “Shutdown option code” = Other than 0 | Decelerates according to Obj.605Bh:00h “Shutdown option code” |
| | 3 (Quick stop command) | Obj.605Ah:00h “Quick stop option code” = 0 | Decelerates according to Obj.3506h:00h “Sequence at Servo-Off” |
| | | Obj.605Ah:00h “Quick stop option code” = Other than 0 | Decelerates according to Obj.605Ah:00h “Quick stop option code” |

When Obj.3509h is not 2000 (when main power AC off detection is enabled)

—: N/A

| Status | Obj.6007h:00h “Abort connection option code” Setup value | Target option code Setup value | Deceleration method | | | |
|---|---|---|---|---|---|---|
| | | | Before set time for Obj.3509h:00h “Detection time of main power off” has passed (*2) | → | After set time for Obj.3509h:00h “Detection time of main power off” has passed (*1) | |
| | | | | | Obj.3508h:00h “L/V trip selection upon main power off” : bit 0 | |
| When voltage across P-N drops | — | — | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” is triggered | | | |
| When main power AC (between L1 and L3) is off | 0 (No action) | — | Operational status is retained | → | 0 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” |
| | | | | | 1 | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is triggered |
| | 1 (Fault signal) | Obj.605Eh:00h “Fault reaction option code” = 0 | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered | | | |
| | | Obj.605Eh:00h “Fault reaction option code” = Other than 0 | Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered after deceleration according to Obj.605Eh:00h “Fault reaction option code” | → | 0 | Decelerates according to Obj.3507h:00h “Sequence upon main power off”<br>After deceleration, Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered<br>Transition to post-stop operation by Obj.3510h:00h “Sequence at alarm” |

| Status | Obj.6007h: 00h “Abort connection option code” Setup value | Target option code Setup value | Deceleration method | | | |
|---|---|---|---|---|---|---|
| | | | Before set time for Obj.3509h:00h “Detection time of main power off” has passed (*2) | → | After set time for Obj.3509h:00h “Detection time of main power off” has passed (*1) | |
| | | | | | Obj.3508h:00h “L/V trip selection upon main power off” : bit 0 | |
| When main power AC (between L1 and L3) is off | 1 (Fault signal) | Obj.605Eh:00h “Fault reaction option code” = Other than 0 | Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered after deceleration according to Obj.605Eh:00h “Fault reaction option code” | → | 1 | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is triggered (Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)” is triggered after deceleration) |
| | 2 (Disable voltage command) | Obj.605Bh:00h “Shutdown option code” = 0 | Decelerates according to Obj.3506h:00h “Sequence at Servo-Off” | → | 0 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” (*3) |
| | | | | | 1 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” (*3) |
| | | Obj.605Bh:00h “Shutdown option code” = Other than 0 | Decelerates according to Obj.605Bh:00h “Shutdown option code” | → | 0 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” |
| | | | | | 1 | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is triggered |
| | 3 (Quick stop command) | Obj.605Ah:00h “Quick stop option code” = 0 | Decelerates according to Obj.3506h:00h “Sequence at Servo-Off” | → | 0 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” (*3) |
| | | | | | 1 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” (*3) |
| | | Obj.605Ah:00h “Quick stop option code” = Other than 0 | Decelerates according to Obj.605Ah:00h “Quick stop option code” | → | 0 | Decelerates according to Obj.3507h:00h “Sequence upon main power off” |
| | | | | | 1 | Decelerates according to Obj.3510h:00h “Sequence at alarm” after Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is triggered |

*1 Not executed if the actual speed falls below 30 r/min before the time set by Obj.3509h:00h “Detection time of main power off” elapses.

*2 Not executed if the time set in Obj.3509h:00h “Detection time of main power off” is 70 ms or less.

*3 If the time set in Obj.3509h:00h “Detection time of main power off” exceeds 70 ms, a supplemental deceleration stop is made.

Example of deceleration stop operation due to main power off

A: Once 70 ms elapses after main power OFF, deceleration stop is started by Obj.6007h:00h “Abort connection option code” .

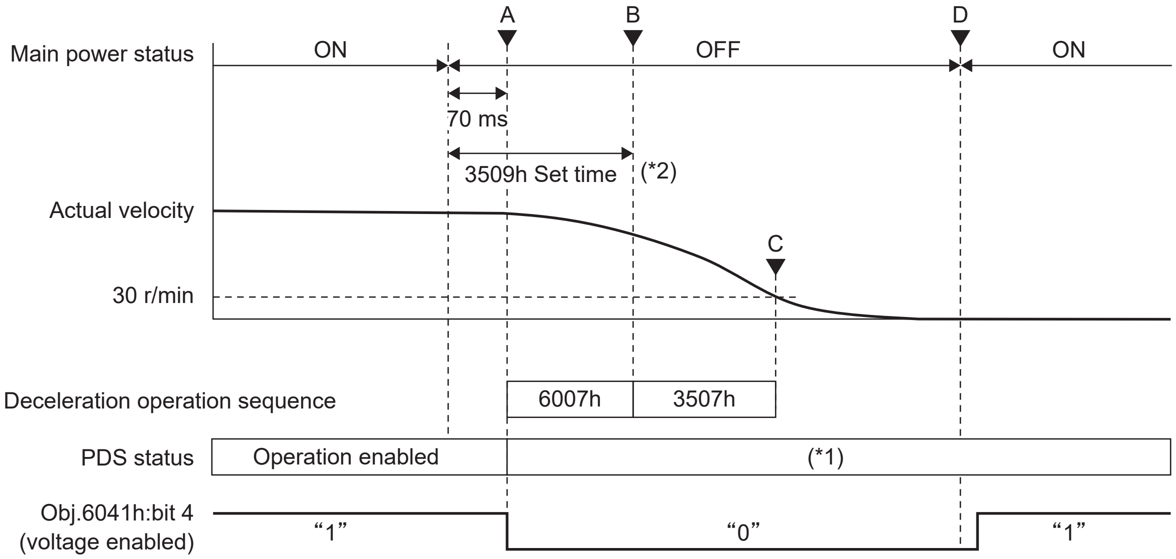
B: When the time set by Obj.3509h:00h “Detection time of main power off” elapses after main power OFF, switches to deceleration stop by Obj.3507h:00h “Sequence upon main power off” .

C: The motor stops when the actual speed is detected as being 30 r/min or less.

D: When the main power is on, Obj.6041h:bit 4 “Statusword:voltage enabled” changes to 1.

**Notes**

- If main power off is detected during Obj.3506h:00h “Sequence at Servo-Off” , Obj.3506h:00h “Sequence at Servo-Off” performs a deceleration stop, after which a transition is made to the operation following a stop by Obj.3507h:00h “Sequence upon main power off” .



*1 The PDS status during deceleration and after stopping will differ depending on this object, and Obj.3508h:00h “L/V trip selection upon main power off” : bit 0, and the set value for Obj.3509h.See the table “PDS status at deceleration stop operation” shown in “2”.

*2 When Obj.3509h:00h “Detection time of main power off” = 2000 (main AC power off detection disabled) and if the actual speed falls below 30 r/min before the time set by Obj.3509h:00h “Detection time of main power off” elapses, deceleration stop processing by Obj.3507h is not performed.

### PDS status at deceleration stop operation

Before the time set by Obj.3509h:00h “Detection time of main power off” elapses, or when Obj.3509h:00h “Detection time of main power off” = 2000 (when main power AC off detection is disabled)

| Obj.6007h:00h “Abort connection option code” Setup value | PDS status during deceleration | PDS status after stopping (approx. 30 r/min or below) |
|---|---|---|
| 0 | Current status retained | When the PDS status at main power off is “Operation enabled”: Operation enabled |
| | | When the PDS status at main power off is “Quick stop active”: Switch on disabled |
| 1 | Fault reaction active | Fault |
| 2 | Current status retained | Switch on disabled |
| 3 | Quick stop active | Switch on disabled |

**Notes**

- Obj.3508h:00h “L/V trip selection upon main power off” : Not dependent on the set value for bit 0.

After the time set by Obj.3509h:00h “Detection time of main power off” elapses

—: No applicable conditions

| Obj.6007h:00h “Abort connection option code” Setup value | Target option code Setup value | Obj.3508h:00h “L/V trip selection upon main power off” : bit 0 set value | PDS status during deceleration | PDS status after stopping (approx. 30 r/min or below) |
|---|---|---|---|---|
| 0 | — | 0 | Current status retained | When the PDS status at main power off is “Operation enabled”: Ready to switch on |
| | | | | When the PDS status at main power off is “Quick stop active”: Switch on disabled |
| | | 1 | Fault reaction active | Fault |
| 1 | — | — | Fault reaction active | Fault |
| 2 | Obj.605Bh:00h “Shutdown option code” = 0 | — | Current status retained | Switch on disabled |
| | Obj.605Bh:00h “Shutdown option code” = Other than 0 | 0 | Current status retained | Switch on disabled |
| | | 1 | Fault reaction active | Fault |
| 3 | Obj.605Ah:00h “Quick stop option code” = 0 | — | Quick stop active | Switch on disabled |
| | Obj.605Ah:00h “Quick stop option code” = Other than 0 | 0 | Quick stop active | Switch on disabled |
| | | 1 | Fault reaction active | Fault |

### 6.6.8.2.2 Quick stop option code (605Ah)

Sets the motor deceleration stop method when the PDS command “Quick Stop” is received.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 605Ah | 00h | Quick stop option code | — | -2 to 7 | I16 | rw | No | ALL | Yes | A |

- Sets the sequence for use during Quick stop. The definition differs by control mode.
  Settings other than the following values are prohibited. If set to a prohibited value, an abortcode will be triggered.
- pp, csp, ip, csv, pv
  - -1, -2: Manufacturer use
  - 0: Transitions to “Switch on disabled” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switch on disabled” after the motor is stopped by Obj.6084h:00h “Profile deceleration” .
  - 2: Transitions to “Switch on disabled” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” .
  - 3: Transitions to “Switch on disabled” after the motor is stopped by Obj.60C6h:00h “Max deceleration” .
  - 5: Transitions to “Quick stop active” after the motor is stopped by Obj.6084h:00h “Profile deceleration” . (*1)
  - 6: Transitions to “Quick stop active” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” . (*1)
  - 7: Transitions to “Quick stop active” after the motor is stopped by Obj.60C6h:00h “Max deceleration” . (*1)
- hm
  - -1, -2: Manufacturer use
  - 0: Transitions to “Switch on disabled” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switch on disabled” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” .
  - 2: Transitions to “Switch on disabled” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” .
  - 3: Transitions to “Switch on disabled” after the motor is stopped by Obj.60C6h:00h “Max deceleration” .
  - 5: Transitions to “Quick stop active” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” . (*1)
  - 6: Transitions to “Quick stop active” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” . (*1)
  - 7: Transitions to “Quick stop active” after the motor is stopped by Obj.60C6h:00h “Max deceleration” . (*1)
- cst, tq
  - -1, -2: Manufacturer use
  - 0: Transitions to “Switch on disabled” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1, 2: Transitions to “Switch on disabled” after the motor is stopped by Obj.6087h:00h “Torque slope” .
  - 3: Transitions to “Switch on disabled” after the motor is stopped by zero torque.
  - 5, 6: Transitions to “Quick stop active” after the motor is stopped by Obj.6087h:00h “Torque slope” . (*1)
  - 7: Transitions to “Quick stop active” after the motor is stopped by zero torque. (*1)

*1 If the main power is shut off when Obj.6007h:00h “Abort connection option code” = 3, it transitions to “Switch on disabled.”

There are other related objects. For details, see the first part of *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

—: N/A

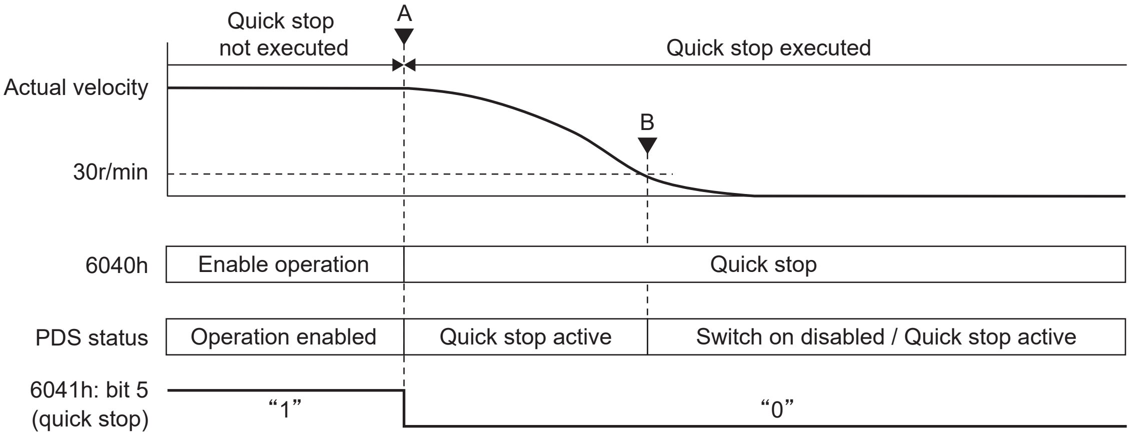
| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6085h | 00h | Quick stop deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| 60C6h | 00h | Max deceleration | Command unit/$s^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>hm<br>pv<br>ip | Yes | A |
| 3506h | 00h | Sequence at Servo-Off | — | 0 to 9 | I16 | rw | No | ALL | Yes | B |

Example of deceleration stop operation by Quick stop command

A: Deceleration stop starts when Obj.6040h:bit 2 “Controlword:quick stop” changes from 1 to 0. The PDS status during deceleration is “Quick stop active”.

B: The motor stops when the actual speed is detected as being 30 r/min or less. Once stopped, the PDS status changes to “Switch on disabled” or “Quick stop active”.



### 6.6.8.2.3 Shutdown option code (605Bh)

Sets the motor deceleration stop method when the PDS commands “Shutdown” and “Disable voltage” are received.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 605Bh | 00h | Shutdown option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |

- Sets the sequence when the PDS commands “Shutdown” and “Disable voltage” are received. The definition differs by control mode.

  Settings other than the following values are prohibited.

When the PDS command “Shutdown” is received

- pp, csp, ip, csv, pv
  - 0: Transitions to “Ready to switch on” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Ready to switch on” after the motor is stopped by Obj.6084h:00h “Profile deceleration” .
- hm
  - 0: Transitions to “Ready to switch on” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Ready to switch on” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” .
- cst, tq
  - 0: Transitions to “Ready to switch on” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Ready to switch on” after the motor is stopped by Obj.6087h:00h “Torque slope” .

When the PDS command “Disable voltage” is received

- pp, csp, ip, csv, pv
  - 0: Transitions to “Switch on disabled” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switch on disabled” after the motor is stopped by Obj.6084h:00h “Profile deceleration” .
- hm
  - 0: Transitions to “Switch on disabled” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switch on disabled” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” .
- cst, tq
  - 0: Transitions to “Switch on disabled” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switch on disabled” after the motor is stopped by Obj.6087h:00h “Torque slope” .

There are other related objects. For details, see the first part of *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

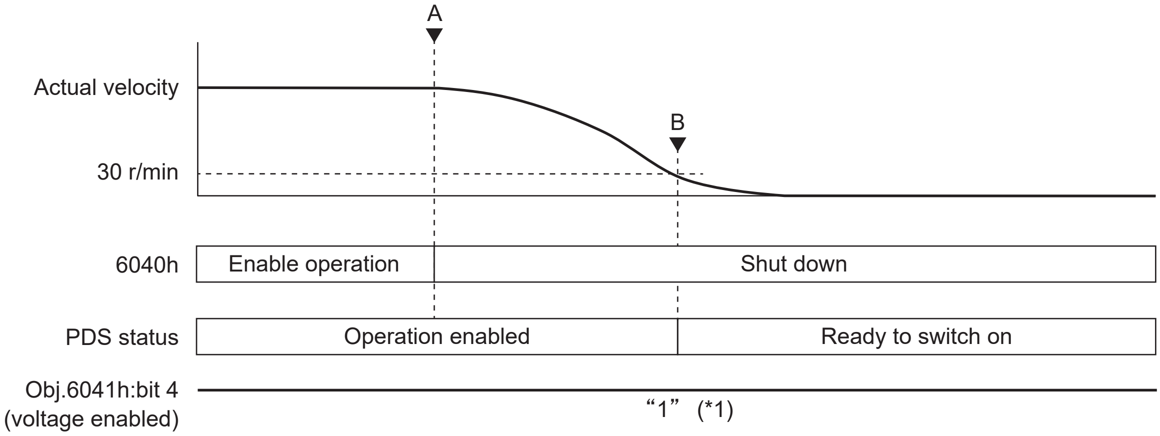
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| 3506h | 00h | Sequence at Servo-Off | — | 0 to 9 | I16 | rw | No | ALL | Yes | B |

Example of deceleration stop operation by Shutdown command

A: Starts deceleration stop when the PDS command “Shutdown” is received. The PDS status during deceleration remains as “Operation enabled”.

B: The motor stops when the actual speed is detected as being 30 r/min or less. Once stopped, the PDS status changes to "Ready to switch on".



*1 Obj.6041h:bit 4 "Statusword:voltage enabled" remains unchanged at 1.

### 6.6.8.2.4 Disable Operation Option Code (605Ch)

Sets the motor deceleration stop method when the PDS command “Disable operation” is received.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 605Ch | 00h | Disable operation option code | — | 0 to 1 | I16 | rw | No | ALL | Yes | A |

- Sets the sequence when the PDS command “Disable operation” is received. The definition differs by control mode.

  Settings other than the following values are prohibited.
- pp, csp, ip, csv, pv
  - 0: Transitions to “Switched on” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switched on” after the motor is stopped by Obj.6084h:00h “Profile deceleration” .
- hm
  - 0: Transitions to “Switched on” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switched on” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” .
- cst, tq
  - 0: Transitions to “Switched on” after the motor is stopped by Obj.3506h:00h “Sequence at Servo-Off” .
  - 1: Transitions to “Switched on” after the motor is stopped by Obj.6087h:00h “Torque slope” .

There are other related objects. For details, see the first part of *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

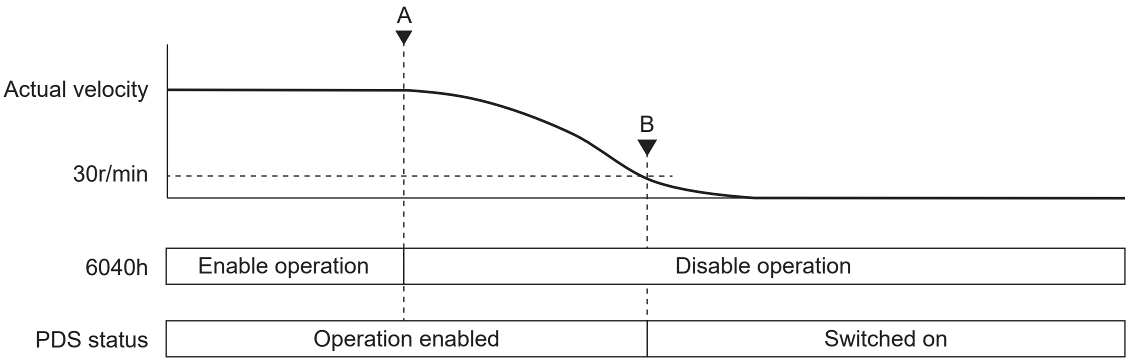
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| 3506h | 00h | Sequence at Servo-Off | — | 0 to 9 | I16 | rw | ALL | ALL | Yes | B |

Example of deceleration stop operation by the Disable operation command

A: When the PDS command “Disable operation” is received, deceleration stop is started. The PDS status during deceleration remains as “Operation enabled”.

B: The motor stops when the actual speed is detected as being 30 r/min or less. Once stopped, the PDS status changes to “Switched on”.


A
B
Actual velocity
30r/min
6040h
Enable operation
Disable operation
PDS status
Operation enabled
Switched on

### 6.6.8.2.5 Halt option code (605Dh)

Sets the motor deceleration stop method when Obj.6040h:00h “Controlword” :bit 8 “halt” is set to “1”.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 605Dh | 00h | Halt option code | — | -1 to 3 | I16 | rw | No | ALL | Yes | A |

- Sets the sequence during Halt operation. The definition differs by control mode.
  Settings other than the following values are prohibited.
- pp, csp, ip, csv, pv
  - -1: Manufacturer use
  - 1: Retains “Operation enabled” after the motor is stopped by Obj.6084h:00h “Profile deceleration” .
  - 2: Retains “Operation enabled” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” .
  - 3: Retains “Operation enabled” after the motor is stopped by Obj.6072h:00h “Max torque” and Obj.60C6h:00h “Max deceleration” .
- hm
  - -1: Manufacturer use
  - 1: Retains “Operation enabled” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” .
  - 2: Retains “Operation enabled” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” .
  - 3: Retains “Operation enabled” after the motor is stopped by Obj.6072h:00h “Max torque” and Obj.60C6h:00h “Max deceleration” .
- cst, tq
  - -1: Manufacturer use
  - 1, 2: Retains “Operation enabled” after the motor is stopped by Obj.6087h:00h “Torque slope” .
  - 3: Retains “Operation enabled” after the motor is stopped by zero torque.

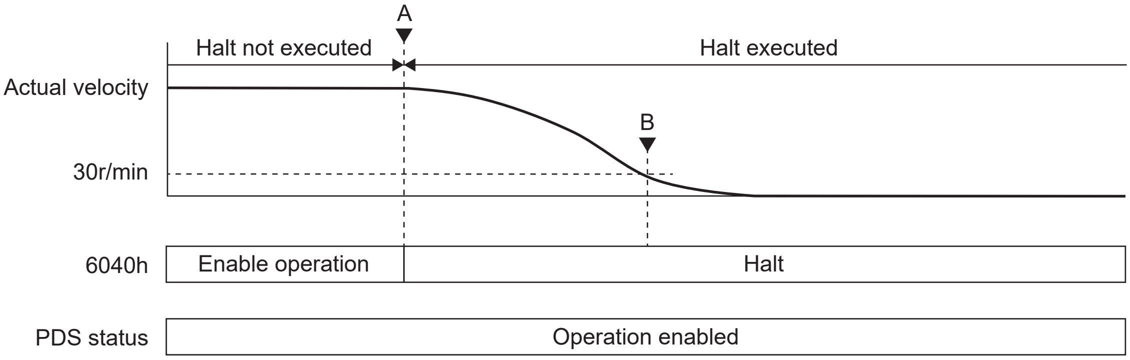
There are other related objects. For details, see the first part of *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |

Example of deceleration stop operation by Halt function

A: Deceleration stop starts when Obj.6040h:bit 8 “Controlword halt” changes from 0 to 1. The PDS status during deceleration remains as “Operation enabled”.

B: The motor stops when the actual speed is detected as being 30 r/min or less. Once stopped, the PDS status remains as “Operation enabled”.


A
Halt not executed
Halt executed
Actual velocity
B
30r/min
6040h
Enable operation
Halt
PDS status
Operation enabled

### 6.6.8.2.6 Fault reaction option code (605Eh)

Sets the motor deceleration method when an EtherCAT communication-related alarm is triggered.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 605Eh | 00h | Fault reaction option code | — | 0 to 2 | I16 | rw | No | ALL | Yes | A |

- Sets the sequence for when an alarm is triggered. The definition differs by control mode.
  Settings other than the following values are prohibited.

1 When Err80.☐.☐, Err 81.☐.☐, Err85.☐.☐, or Err88.☐.☐ is triggered

- pp, csp, ip, csv, pv
  - 0: Transitions to “Fault” after the motor is stopped by Obj.3510h:00h “Sequence at alarm” .
  - 1: Transitions to “Fault” after the motor is stopped by Obj.6084h:00h “Profile deceleration” .
  - 2: Transitions to “Fault” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” .
- hm
  - 0: Transitions to “Fault” after the motor is stopped by Obj.3510h:00h “Sequence at alarm” .
  - 1: Transitions to “Fault” after the motor is stopped by Obj.609Ah:00h “Homing acceleration” .
  - 2: Transitions to “Fault” after the motor is stopped by Obj.6085h:00h “Quick stop deceleration” .
- cst, tq
  - 0: Transitions to “Fault” after the motor is stopped by Obj.3510h:00h “Sequence at alarm” .
  - 1, 2: Transitions to “Fault” after the motor is stopped by Obj.6087h:00h “Torque slope” .

2 When an alarm other than the alarms specified in 1 above is triggered

0, 1, 2: Transitions to “Fault” after the motor is stopped by Obj.3510h:00h “Sequence at alarm” .

There are other related objects. For details, see the first part of *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

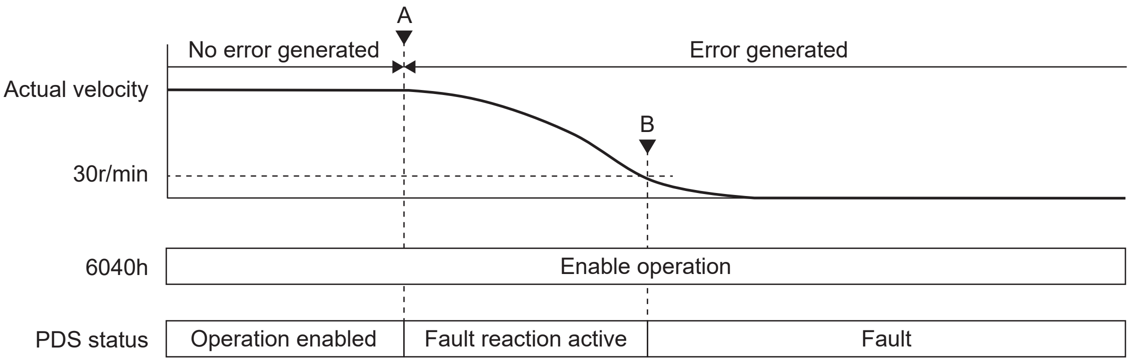
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6084h | 00h | Profile deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>ip<br>csp<br>csv | Yes | A |
| 6085h | 00h | Quick stop deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 609Ah | 00h | Homing acceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | hm | Yes | A |
| 3510h | 00h | Sequence at alarm | — | 0 to 7 | I16 | rw | No | ALL | Yes | B |

Example of deceleration stop operation due to alarm triggering

A: Deceleration stop starts when an alarm is triggered. The PDS status during deceleration is “Fault reaction active”.

B: The motor stops when the actual speed is detected as being 30 r/min or less. Once stopped, the PDS status changes to “Fault”.


A
No error generated
Error generated
Actual velocity
B
30r/min
6040h
Enable operation
PDS status
Operation enabled
Fault reaction active
Fault

### 6.6.8.2.7 Sequence During Over-travel Inhibit Inputs (POT, NOT)

Sets the post-input operation sequence input for over-travel inhibit inputs (POT, NOT).

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3504h | 00h | Over-travel inhibit input setup | — | 0 to 2 | I16 | rw | No | ALL | Yes | C |
| | Sets the input operations for the over-travel inhibit inputs (POT, NOT).<br>● 0: POT -> Positive direction over-travel inhibit, NOT -> Negative direction over-travel inhibit. If POT is input during positive direction travel or NOT is input during negative direction travel, Obj.3505h:00h “Sequence at over-travel inhibit” brings it to a stop.<br>● 1: POT -> Positive direction over-travel inhibit, NOT -> Negative direction over-travel inhibit. If POT is input during positive direction travel or NOT is input during negative direction travel, it comes to a stop in accordance with the following.<br>• pp, csp, ip, csv, pv<br>Motor stopped by Obj.6085h:00h “Quick stop deceleration”<br>• cst, tq<br>Motor stopped by Obj.6087h:00h “Torque slope”<br>● 2: POT or NOT input activates Err38.0.0 “Over-travel inhibit input protection 1” | | | | | | | | | |
| 3505h | 00h | Sequence at over-travel inhibit | — | 0 to 2 | I16 | rw | No | ALL | Yes | C |
| | ● Sets the status for during deceleration and after coming to a stop after over-travel inhibit inputs (POT, NOT) are entered when Obj.3504h:00h “Over-travel inhibit input setup” = 0. | | | | | | | | | |
| 3511h | 00h | Torque setup for emergency stop | % | 0 to 500 | I16 | rw | No | ALL | Yes | B |
| | ● Sets the torque limit for emergency stop.<br>The normal torque limit is used when this setup value is 0. | | | | | | | | | |
| 36A2h | 00h | Over-travel inhibit release level setup | Command unit | 0 to 2147483647 | I32 | rw | No | csp | Yes | B |
| | ● Sets the position deviation amount using an absolute value for canceling the over-travel inhibited state. If the position deviation amount is greater than the set value, the over-travel inhibit state cannot be canceled. If Obj.3504h:00h “Over-travel inhibit input setup” ≠ 1, set Obj.36A2h:00h “Over-travel inhibit release level setup” = 0. | | | | | | | | | |

There are other related objects. For details, see the first part of *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* and *“4.2.7.3 Message When an Error Occurs”* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6085h | 00h | Quick stop deceleration | Command unit/s$^2$ | 0 to 4294967295 | U32 | rw | RxPDO | pp<br>pv<br>hm<br>ip<br>csp<br>csv | Yes | A |
| 6087h | 00h | Torque slope | 0.1%/s | 0 to 4294967295 | U32 | rw | RxPDO | tq<br>cst | Yes | A |
| 603Fh | 00h | Error code | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

**— Precautions —**

- The sensor must be set up so that the over-travel inhibit inputs (POT, NOT) can be input correctly.
- Operation cannot be guaranteed if not set up correctly (NOT installed on the positive direction travel side, POT installed on the negative direction travel side, etc.).

- Install the device at a position that takes into account the amount of movement required until deceleration stops.
- If the torque limit and deceleration set values are low, the amount of movement necessary until deceleration stops may increase.

### 6.6.8.3 Digital Inputs, Digital Outputs

Of the function signals assigned using servo parameters 3400h to 3407h, 3410h, 3411h, and 3412h, each bit of digital inputs and digital outputs represents the logic input states of positive limit switch (POT), negative limit switch (NOT), home switch (HOME), EXT1, EXT2, E-STOP, and SI-MON1 to SI-MON5, as well as the logical output settings of EX-OUT1 and set_brake.

#### 6.6.8.3.1 Digital inputs (60FDh)

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60FDh | 00h | Digital inputs | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays the logic input status of external input signals.

| bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 |
|---|---|---|---|---|---|---|---|---|
| Function | (Not Supported) | | | | | | RET status [RET-STAT] | [INP] |
| bit | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| Function | [SI-MON5] / [E-STOP] | [SI-MON4] | [SI-MON3] | [SI-MON2] / [EXT2] | [SI-MON1] / [EXT1] | [RET] | Velocity integral clear [VI-CLR] | (reserved) |
| bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| Function | (reserved) | | | | | | | |
| bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Function | (reserved) | | | | (Not Supported) | home switch [HOME] | positive limit switch [POT] | negative limit switch [NOT] |

* The symbols in [ ] are symbol names for I/O connector input signals and output signals.

The details of each bit are as follows.

| Value | Definition |
|---|---|
| 0 | Switched off (logic input status OFF) |
| 1 | Switched on (logic input status ON) |

Obj.60FDh:00h “Digital inputs” :bit 2 “home switch” , bit 1 “positive limit switch” , and bit 0 “negative limit switch” indicate the signal status of the near home input (HOME) of the parallel I/O connector, positive direction over-travel inhibit input (POT), and negative direction over-travel inhibit input (NOT).

bit 17 “VI-CLR” is set to 1 when the velocity integral value is cleared by internal processing or by setting Obj.60FEh: “Digital outputs” :bit 20 “vel-loop integral clear” .

#### 6.6.8.3.2 Digital outputs (60FEh)

**— Precautions —**

- If using this object for set brake signal control, make sure to use PDO and enable the PDO watchdog. Using SDO is unsafe as it may not be able to determine that communication has been interrupted, causing the brake to remain released.
- If using the set brake signal, assign output signals (settings Obj.3410h:00h “SO1 output selection” , Obj.3411h:00h “SO2 output selection” , and Obj.3412h:00h “SO3 output selection” ). Also assign

output signals (settings Obj.3410h:00h “SO1 output selection” , Obj.3411h:00h “SO2 output selection” , and Obj.3412h:00h “SO3 output selection” ) if using the external brake release signal (BRK-OFF) instead of the set brake signal.

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>60FEh</td><td>—</td><td>Digital outputs</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="11">● Used when operating the output transistor for external output signals.
<table>
<tr><td>bit</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td></tr>
<tr><td>Function</td><td colspan="3">(Not Supported)</td><td>Time-stamp reference time reset</td><td colspan="4">(Not Supported)</td></tr>
<tr><td>bit</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td></tr>
<tr><td>Function</td><td colspan="3">(Not Supported)</td><td>vel-loop integral clear</td><td>vel-loop torque limit</td><td colspan="2">(Not Supported)</td><td>EX-OUT1</td></tr>
<tr><td>bit</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td>Function</td><td colspan="8">(reserved)</td></tr>
<tr><td>bit</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Function</td><td colspan="7">(reserved)</td><td>set brake</td></tr>
</table></td></tr>
<tr><td>60FEh</td><td>00h</td><td>Number of entries</td><td>—</td><td>2</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the number of Obj.60FEh: “Digital outputs” Sub-Indexes.</td></tr>
<tr><td>60FEh</td><td>01h</td><td>Physical outputs</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Operates to output external output signals.</td></tr>
<tr><td>60FEh</td><td>02h</td><td>Bit mask</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>ALL</td><td>Yes</td><td>A</td></tr>
<tr><td colspan="11">● Sets the external operation masking function for external output signals.</td></tr>
</table>

The details of each bit are shown in the table below.

Sub-Index 01h: Physical outputs

| bit | Name | value | Note |
|---|---|---|---|
| 0 | set brake | 0 | don’t set brake (= brakes don’t operate) |
| | | 1 | set brake (= brakes operate) |
| 16 | EX-OUT1 | 0 | Switched off (output transistor OFF) |
| | | 1 | Switched on (output transistor ON) |
| 19 (*1) (*3) | vel-loop torque limit | 0 | Velocity control loop torque limit disabled |
| | | 1 | Velocity control loop torque limit enabled |
| 20 (*2) (*3) | vel-loop integral clear | 0 | Speed integration value not cleared |
| | | 1 | Speed integration value cleared |
| 28 (*4) | Timestamp reference time reset | 0 | The following values are not incorporated.<br>● Obj.430Eh: “Timestamp reference time” : Obj.430Eh:01h “Timestamp reference time setting 1”<br>● Obj.430Eh: “Timestamp reference time” : Obj.430Eh:02h “Timestamp reference time setting 2” |

| bit | Name | value | Note |
|---|---|---|---|
| 28 (*4) | Timestamp reference time reset | 1 | The following values are incorporated when this bit changes from 0 to 1.<br>● Obj.430Eh: “Timestamp reference time” : Obj.430Eh:01h “Timestamp reference time setting 1”<br>● Obj.430Eh: “Timestamp reference time” : Obj.430Eh:02h “Timestamp reference time setting 2” |

*1 Enables or disables the torque limit function of the velocity control loop by Obj.4312h:00h “Velocity control loop torque limit” .

*2 The velocity integral value is always 0 when bit 20 = 1.

*3 For details, see the control block diagrams shown in *“6.6.5 Position Control Function (pp, csp, ip, hm)”* to *“6.6.7 Torque Control Function (tq, cst)”* .

*4 When synchronizing multiple axes, change Obj.60FEh:01h “Physical outputs” :bit 28 “Timestamp reference time reset” for all axes simultaneously.

Also, perform changes for bit 28 “Timestamp reference time reset” under the following conditions.

- DC synchronous mode or SM2 synchronous mode
- The ESM state is the OP state

### Sub-Index 02h: Bit mask

| bit | Name | value | Note |
|---|---|---|---|
| 0 | Bit mask for set brake | 0 | Disable output (set brake output disabled) |
| | | 1 | Enable output (set brake output enabled) |
| 16 | Bit mask for EX-OUT1 | 0 | Disable output (EX-OUT1 output disabled) |
| | | 1 | Enable output (EX-OUT1 output enabled) |
| 19 | Bit mask for vel-loop torque limit | 0 | Disable output (vel-loop torque limit disabled) |
| | | 1 | Enable output (vel-loop torque limit enabled) |
| 20 | Bit mask for vel-loop integral clear | 0 | Disable output (vel-loop integral clear disabled) |
| | | 1 | Enable output (vel-loop integral clear enabled) |
| 28 | Bit mask for Timestamp reference time reset | 0 | Disable output (Timestamp reference time reset disabled) |
| | | 1 | Enable output (Timestamp reference time reset enabled) |

**Notes**

- If the bit mask is disabled, this product internally processes each physical output as a default value (set value = 0).

The output transistor state for each communication state transitions as shown in the following table.

—: No applicable conditions

| Symbol | 3724h Setup value | 60FEh setup value | | Output transistor state | | | |
|---|---|---|---|---|---|---|---|
| | | 01h (Physical outputs) | 02h (Bit mask) | When reset | Communication established (*1) | When communication is interrupted (*1) | Communication re-established (*1) |
| set brake | — | 0 | 0 | set brake = 1 (Brake ON) | set brake = 1 (Brake ON) | set brake = 1 (Brake ON) | set brake = 1 (Brake ON) |
| | | 1 | | | | | |
| | | 0 | 1 | set brake = 1 (Brake ON) | set brake = 0 | set brake = 1 (Brake ON) | set brake = 0 |
| | | 1 | | | set brake = 1 (Brake ON) | | set brake = 1 (Brake ON) |
| EX-OUT1 | bit 0 = 0 (Retained) | 0 | 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | | | |

| Symbol | 3724h Setup value | 60FEh setup value | | Output transistor state | | | |
|---|---|---|---|---|---|---|---|
| | | 01h (Physical outputs) | 02h (Bit mask) | When reset | Communication established (*1) | When communication is interrupted (*1) | Communication re-established (*1) |
| EX-OUT1 | bit 0 = 0 (Retained) | 0 | 1 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0<br>(Retained) | EX-OUT1 = 0 |
| | | 1 | | | EX-OUT1 = 1 | EX-OUT1 = 1<br>(Retained) | EX-OUT1 = 1 |
| | bit 0 = 1 (Initialized) | 0 | 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 | EX-OUT1 = 0 |
| | | 1 | | | EX-OUT1 = 1 | | EX-OUT1 = 1 |
| vel-loop torque limit | — | 0 | 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 | vel-loop torque limit = 0 |
| | | 1 | | | vel-loop torque limit = 1<br>(Torque limited) | | vel-loop torque limit = 1<br>(Torque limited) |
| vel-loop integral clear | — | 0 | 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 | vel-loop integral clear = 0 |
| | | 1 | | | vel-loop integral clear = 1<br>(Speed integration value cleared) | | vel-loop integral clear = 1<br>(Speed integration value cleared) |
| Timestamp reference time reset | — | 0 | 0 | Timestamp reference time reset = 0 | Timestamp reference time reset = 0 | Timestamp reference time reset = 0 | Timestamp reference time reset = 0 |
| | | 1 | | | | | |
| | | 0 | 1 | Timestamp reference time reset = 0 | Timestamp reference time reset = 0 | Timestamp reference time reset = 0 | Timestamp reference time reset = 0 |
| | | 1 | | | Timestamp reference time reset = 0 -> 1 (incorporates the values of 430Eh:01h and 430Eh:02h) | | Timestamp reference time reset = 0 -> 1 (incorporates the values of 430Eh:01h and 430Eh:02h) |

*1 “Communication established”, “Communication interrupted”, “Communication re-established” refer to the meanings in the following table.

| | |
|---|---|
| Communication established | The ESM state is PreOP or higher |
| When communication is interrupted (*2) | RxPDO communication is not possible (ESM status transitions from OP to something other than OP)<br>or<br>SDO communication is not possible (ESM status transitions to Init) |
| Communication re-established | Obj.60FEh:01h or Obj.60FEh:02h was written successfully |

*2 When using Obj.60FEh: “Digital outputs” , map to RxPDO.

Related objects

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3724h | 00h | Communication function extended setup 3 | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | C |
| | | ● bit 0: EX-OUT1 output status setting at the time of communication interrupted after EtherCAT communication is established<br>0: Retained<br>1: Initialized (output when EX-OUT1 = 0)<br>● bit 1: Manufacturer use<br>Please fix to 0. | | | | | | | | |
| 4312h | 00h | Velocity control loop torque limit | 0.1% | 0 to 65535 | U16 | rw | RxPDO | ALL | No | A |
| | | ● If Obj.60FEh:01h “Physical outputs” :bit 19 = 1 is set while Obj.60FEh:02h “Bit mask” :bit 19 = 1, the torque command value generated by the velocity control loop is limited by the setting value. | | | | | | | | |

## 6.6.8.4 Position Information

### 6.6.8.4.1 Initialization Timing for Position Information

The product initializes (presets) position-related objects at the following times.

**■ Initialization timing (condition)**

- When control power is turned on
- When communication is established (when ESM state transitions from Init → PreOP)
- When homing is completed
- When clearing multi-turn data
- When operation of the Set-up Support Software (PANATERM ver.7) function (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) ends
- When executing Config for Set-up Support Software (PANATERM ver.7)
- When Err27.4.0 “Position command error protection” occurs

**■ Object being initialized**

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F04h | 00h | Position command internal value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 4F0Dh | 00h | External scale position | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL (*1) | No | X |
| 4F41h (*2) | 02h | Multi-turn data | Rotation | -2147483648 to 2147483647 | I32 | ro | TxPDO (*1) | ALL | No | X |
| 4F48h | 00h | External scale pulse total | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL (*1) | No | X |
| 4F86h | 00h | Hybrid deviation | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp<br>(*1) | No | X |
| 4FA7h | 00h | External scale position (Applied polarity) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL (*1) | No | X |
| 6062h | 00h | Position demand value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |
| 6063h | 00h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 6064h | 00h | Position actual value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| 60FCh | 00h | Position demand internal value | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>ip<br>csp | No | X |

*1 Only supported during full-closed control.

*2 This is only supported when multi-turn data is cleared.

These objects are initialized (preset) based on Obj.6063h:00h “Position actual internal value” , which indicates the motor feedback position, taking into account the electronic gear function, sign conversion by polarity, home offset, etc., as described below.

Also, changes in the electronic gear ratio, polarity, and home offset set values are reflected at the times described later in this section.

Refer to *“6.6.8.4.4 Initialization of Absolute Encoder (During Semi-closed Control)”* for precautions to be taken when using an absolute encoder.

### 6.6.8.4.2 Electronic Gear Function

The electronic gear is a function that uses a value obtained by multiplying the position control command input from the host device by the electronic gear ratio set by the object as the position command for the position control unit.

This function can be used to set motor rotation and movement amounts arbitrarily on a per-command-unit basis.

This product does not support the setting of electronic gear ratios using the parameters Pr0.08 “Number of command pulses per one motor revolution” , Pr0.09 “Numerator of electronic gear” , and Pr0.10 “Denominator of electronic gear” . Electronic gear ratios are set by the objects Obj.608Fh: “Position encoder resolution” , Obj.6091h: “Gear ratio” , and Obj.6092h: “Feed constant” specified in CoE (CiA402).

The relationship between user-defined units (command units) and internal units (pulse) is calculated using the following equation.

$$\text{Electronic gear ratio} = \frac{\text{Position encoder resolution} \times \text{Gear ratio}}{\text{Feed constant}}$$

Position demand value × Electronic gear ratio = Position demand internal value

#### ■ Precautions

- The electronic gear ratio is only valid within the range of 128000× to 1/1000×.

  If ranges are exceeded, values are saturated at the upper and lower limits of the range and Err88.3.0 “Improper operation error protection” is triggered.
- If the denominator or numerator exceeds the unsigned 64-bit size during calculation of the electronic gear ratio, Err88.3.0 “Improper operation error protection” is triggered.
- If the denominator or numerator exceeds the unsigned 32-bit size in the final calculation result for the electronic gear ratio, Err88.3.0 “Improper operation error protection” is triggered.
- The electronic gear ratio is set using multiple objects.

  Error incidence may increase depending on the combination of settings.
- Obj.608Fh:01h “Encoder increments” is set automatically depending on the encoder resolution.

  This is also set automatically depending on the encoder resolution when using full-closed controls.

  The initial value for Obj.6092h:01h “Feed” is set so that the motor makes a single turn in $2^{23}$ [command unit].

  If using anything other than semi-closed control, set the electronic gear ratio accordingly.
- The setting for the electronic gear ratio is reflected at the times indicated below.
  - When control power is turned on
  - When communication is established (when ESM state transitions from Init → PreOP)
  - When homing is completed
  - When clearing multi-turn data
  - When the Set-up Support Software (PANATERM ver.7) function (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) ends
  - When Config is executed by Set-up Support Software (PANATERM ver.7)
  - When Err27.4.0 “Position command error protection” occurs

  Even if the set values for related objects are changed, they are not reflected as-is.
- The absolute encoder position [pulse/unit]/electronic gear ratio values must be within the range of $-2^{31}$ (-2147483648) to $+2^{31}-1$(2147483647) in the positional information initialization processing when going from Init to PreOP in absolute mode. Operation outside this cannot be guaranteed.

  Check the operational range for the absolute encoder position and the electronic gear ratio.
- The unit for setting the moving distance for the trial run function by Set-up Support Software (PANATERM ver.7) is [command unit].

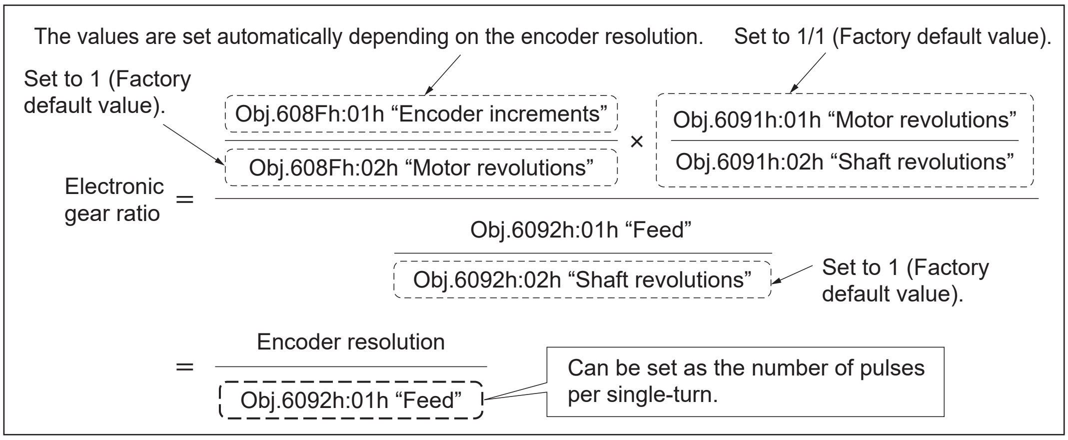
## ■ Electronic gear settings

1 Example of electronic gear settings

Unlike the MINAS A7N series, this product does not support electronic gear settings using “Pr0.08 “Number of command pulses per one motor revolution” ” and “Pr0.09 “Numerator of electronic gear” /Pr0.10 “Denominator of electronic gear” ”.

For electronic gear setting for the MINAS A7N series, see the following.

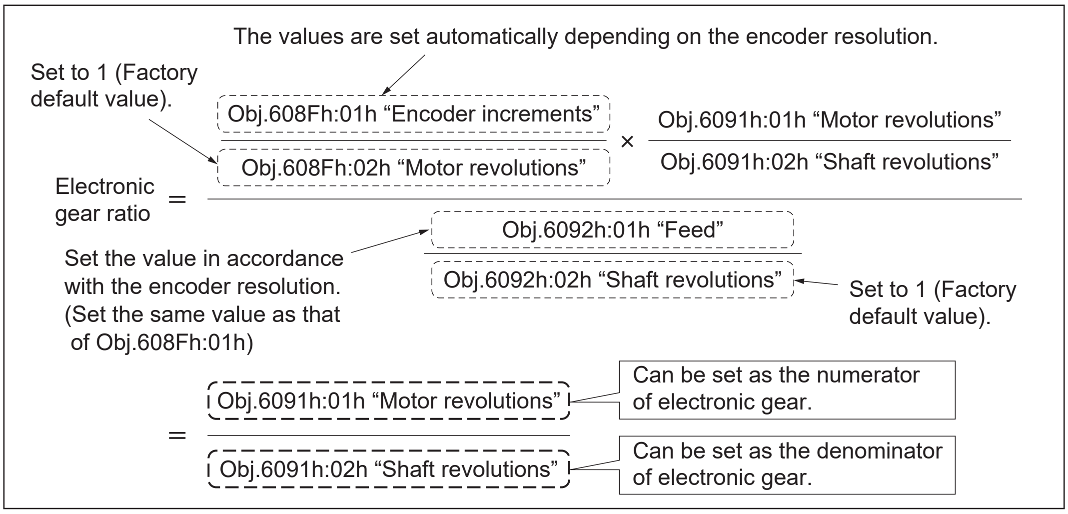
- If setting the electronic gear ratio by setting the command pulse count per motor revolution when using semi-closed controls



Obj.608Fh:01h “Encoder increments” is automatically set based on the resolution of the connected encoder.

By setting Obj.608Fh:02h “Motor revolutions” , Obj.6091h:01h “Motor revolutions” , Obj.6091h:02h “Shaft revolutions” and Obj.6092h:02h “Shaft revolutions” to “1” (factory default value), Obj.6092h:01h “Feed” can be set as the ”command pulse count per motor revolution”.

- If setting the electronic gear ratio by setting the numerator/denominator of electronic gear when using semi-closed controls or full-closed controls



Obj.608Fh:01h “Encoder increments” is automatically set based on the resolution of the connected encoder.

By setting Obj.6092h:01h “Feed” to the same value as the encoder resolution (Obj.608Fh:01h “Encoder increments” ) (factory default value for 27-bit/r encoders) and setting Obj.608Fh:02h “Motor revolutions” and Obj.6092h:02h “Shaft revolutions” to 1 (factory default value), Obj.6091h:01h “Motor revolutions” can be set as the “electronic gear numerator” and Obj.6091h:02h “Shaft revolutions” as the “electronic gear denominator”.

2 Backing up electronic gear setup values

Electronic gear related objects (Obj.6091h:01h “Motor revolutions” , Obj.6091h:02h “Shaft revolutions” , Obj.6092h:01h “Feed” , Obj.6092h:02h “Shaft revolutions” ) are objects to be backed up.

Backing up (writing to EEPROM) is recommended after making any changes.

Backing up means that there is no need to change settings each time you activate the control power.

For backup methods, see *“6.3.5 Store Parameters (Write Object to EEPROM) (1010h)”* .

## ■ Position encoder resolution (Obj.608Fh)

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 608Fh | – | Position encoder resolution | – | – | – | – | – | – | – | – |
| | | ● The encoder resolution is set automatically. | | | | | | | | |
| 608Fh | 00h | Highest sub-index supported | – | 2 | U8 | ro | No | ALL | No | X |
| | | ● Displays the number of Obj.608Fh: “Position encoder resolution” Sub-Indexes. | | | | | | | | |
| 608Fh | 01h | Encoder increments | pulse | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | | ● Indicates the amount of encoder movement. The value automatically sets the encoder resolution.<br>The encoder resolution is also set automatically when using full-closed controls. | | | | | | | | |
| 608Fh | 02h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | ro | No | ALL | No | X |
| | | ● Displays the number of motor rotations. The value is fixed at 1. | | | | | | | | |

This object defines the encoder resolution per one motor revolution.

$$\text{Position encoder resolution} = \frac{\text{Obj.608Fh:01h “Encoder increments”}}{\text{Obj.608Fh:02h “Motor revolutions”}}$$

This object is automatically set based on the information read from the motor connected to this product.

Example: When a 27 bit/r encoder is connected

Obj.608Fh:01h “Encoder increments” = 134217728

Obj.608Fh:02h “Motor revolutions” = 1

Position encoder resolution = 134217728/1 = 134217728

## ■ Gear ratio (Obj.6091h)

–: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6091h | – | Gear ratio | – | – | – | – | – | – | – | – |
| | | ● Sets the gear ratio. | | | | | | | | |
| 6091h | 00h | Number of entries | – | 2 | U8 | ro | No | ALL | No | X |
| | | ● Displays the number of Obj.6091h: “Gear ratio” Sub-Indexes. | | | | | | | | |
| 6091h | 01h | Motor revolutions | r (motor) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P, H |
| | | ● Sets the number of motor rotations. | | | | | | | | |
| 6091h | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P, H |
| | | ● Sets the number of shaft rotations. | | | | | | | | |

This object defines the relationship between the number of motor rotations and the number of shaft rotations after gearbox output.

$$\text{Gear ratio} = \frac{\text{Obj.6091h:01h “Motor shaft revolutions”}}{\text{Obj.6091h:02h “Driving shaft revolutions”}}$$

## ■ Feed constant (Obj.6092h)

─: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 6092h | ─ | Feed constant | ─ | ─ | ─ | ─ | ─ | ─ | ─ | ─ |
| | ● Sets the feed constant. | | | | | | | | | |
| 6092h | 00h | Highest sub-index supported | ─ | 2 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of Obj.6092h: “Feed constant” Sub-Indexes. | | | | | | | | | |
| 6092h | 01h | Feed | Command unit | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P, H |
| | ● Sets the feed amount. | | | | | | | | | |
| 6092h | 02h | Shaft revolutions | r (shaft) | 1 to 4294967295 | U32 | rw | No | ALL | Yes | P, H |
| | ● Sets the number of shaft rotations. | | | | | | | | | |

This object indicates the amount of movement per single turn of the shaft after gearbox output.

$$\text{Feed constant} = \frac{\text{Obj.6092h:01h “Feed”}}{\text{Obj.6092h:02h “Driving shaft revolutions”}}$$

#### 6.6.8.4.3 Polarity (607Eh)

This can be used for setting the polarity (motor rotational direction) for the position command, speed command, torque command, and the various offsets.

This product does not support the setting of rotational direction using the parameter Pr0.00 “Rotational direction setup” . The rotational direction is set by Obj.607Eh:00h “Polarity” as specified in CoE (CiA402). Note that Obj.607Eh:00h “Polarity” is not a direct replacement for the parameter Pr0.00 “Rotational direction setup” , but is enabled when transferring data for corresponding objects in the following table between the CoE (CiA402) processing section and motor control processing section.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P<br>H |

- Sets the polarity for when transferring position commands, speed commands, torque commands, position offsets, speed offsets (added speed) and torque offsets (added torque) values from objects to the internal processing, and for when transferring position feedback, speed feedback and torque feedback values from the internal processing to objects.

| Setup value | Description |
|---|---|
| 0 | No position, velocity or torque sign inversion |
| 224 | With position, velocity or torque sign inversion |
| Other than the above | Not supported (do not attempt to configure settings) |

bits 4 to 0: Reserved
  Set to 0.
bit 5: Torque polarity
  0: No sign inversion
  1: Sign inversion
bit 6: Speed polarity
  0: No sign inversion
  1: Sign inversion
bit 7: Position polarity
  0: No sign inversion
  1: Sign inversion
Target object <commands/settings>
  Obj.607Ah:00h “Target position”
  Obj.60B0h:00h “Position offset”
  Obj.60FFh:00h “Target velocity”
  Obj.60B1h:00h “Velocity offset”
  Obj.6071h:00h “Target torque”
  Obj.60B2h:00h “Torque offset”
<Monitoring>
  Obj.4F04h:00h “Position command internal value (after filtering)”
  Obj.6062h:00h “Position demand value”
  Obj.6064h:00h “Position actual value”
  Obj.606Bh:00h “Velocity demand value”
  Obj.606Ch:00h “Velocity actual value”
  Obj.6074h:00h “Torque demand”
  Obj.6077h:00h “Torque actual value”
  Obj.60FAh:00h “Control effort”
<External input>
  Obj.60FDh:00h “Digital inputs” :bit 0 “negative limit switch” (NOT)
  Obj.60FDh:00h “Digital inputs” :bit 1 “positive limit switch” (POT)
  POT and NOT for external input signals

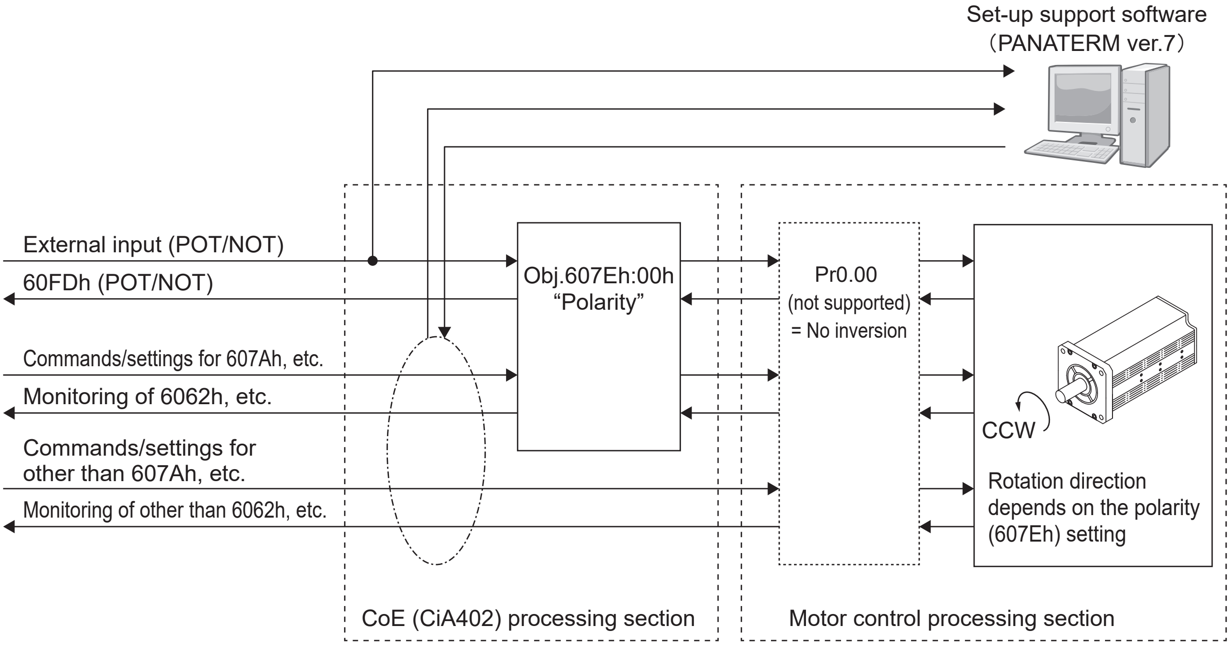
**— Precautions —**

- Set the value for Obj.607Eh:00h “Polarity” to 0 (bits 7 to 5 = all 0) or 224 (bits 7 to 5 = all 1) to ensure that the position, speed, and torque polarity are all the same.
- Operations cannot be guaranteed with other settings.

In addition to the data for corresponding objects in the above table, the set value for Obj.607Eh:00h “Polarity” is reflected in monitor data on Set-up Support Software (PANATERM ver.7) related to the corresponding objects.

Additionally, the setting for Set-up Support Software (PANATERM ver.7) will also be reflected in POT and NOT during the execution of functions such as the trial run function, frequency characteristics analysis function, and Z-phase search function in Obj.607Eh:00h “Polarity” (POT is the positive direction in the command unit.).

Set Obj.607Eh:00h “Polarity” to “Sign inversion” and pay attention to the logic of over-travel inhibit when conducting a trial run, etc.

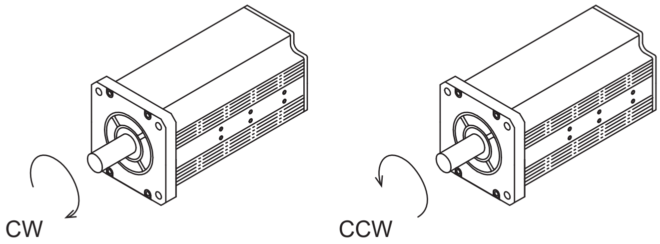


No sign inversion: The rotational direction of the motor for positive direction commands is CCW

Sign inversion: The rotational direction of the motor for positive direction commands is CW

**Notes**

- The motor rotational direction, when viewed from the load side axis end, is defined as CW when clockwise and CCW when counterclockwise.



**— Precautions —**

- The setting for Obj.607Eh:00h “Polarity” is reflected at the times indicated below.
  - When control power is turned on
  - When communication is established (when ESM state transitions from Init → PreOP)
  - When the Set-up Support Software (PANATERM ver.7) function (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) ends
  - When Config is executed by Set-up Support Software (PANATERM ver.7)
  - When Err27.4.0 “Position command error protection” occurs

    Settings for Obj.607Eh:00h “Polarity” are not reflected when homing is completed or when multi-turn data is cleared.

- With the One Minute TUNING function, the motor reciprocates multiple times. If the One Minute TUNING function is executed when only the set value for Obj.607Eh:00h “Polarity” is changed and the set value is not reflected in the operation, the setting for Obj.607Eh:00h “Polarity” is reflected at the end of the first motor operation. This means that the drive direction is reversed from the second motor operation.

  Use the One Minute TUNING function with the setting for Obj.607Eh:00h “Polarity” reflected in advance.
- The setup value for Obj.607Eh:00h “Polarity” when the control power is turned on is reflected in the pulse regeneration function.

### 6.6.8.4.4 Initialization of Absolute Encoder (During Semi-closed Control)

Although there is no need for a homing operation (except when using the absolute encoder in incremental mode) when using an absolute encoder in position control mode, multi-turn data must be cleared when initially starting the machine (Excluding single-turn absolute encoder mode.).

The multi-turn data must be cleared when Err94.3.0 “Homing error protection 2” is triggered during homing in absolute encoder mode.

#### ■ Absolute data

Data read from the absolute encoder (27 bits/r) includes single-turn data that indicates the position within a single turn of the motor and multi-turn data that counts once per turn. Of the two, the multi-turn data uses an electrical counter, so it is configured to be backed up internally.

Both types of data have polarities that increase with CCW rotation when seen from the motor axis end.

Using Obj.3015h:00h “Absolute encoder setup” , you can select whether Err41.0.0 “Absolute counter over error protection” is triggered when multi-turn data overflows.

| | Backup during control power shut off | Data width | Sign | Data range |
|---|---|---|---|---|
| Single-turn data | Unnecessary | 27 bits | No | 0 to 134217727 |
| Multi-turn data | (*2) | 16 bits | No | 0 to 65535 (Max.) (*1) |

*1 Upper-limit values in continuous rotating absolute encoder mode can be set using Obj.3688h:00h “Absolute encoder multi-turn data upper-limit value” .

Except when in continuous rotating absolute encoder mode, the maximum value will be 65535.

*2 Backup during power shut off will vary depending on Obj.3015h:00h “Absolute encoder setup” .

| Absolute encoder type | Obj.3015h:00h “Absolute encoder setup” | |
|---|---|---|
| | 0, 2, 4 | 1, 3 |
| Battery backup | Battery required | Battery not required |
| Batteryless | Battery not required | |

The product initializes position information at the times listed in *“6.6.8.4.1 Initialization Timing for Position Information”* .

With a 27-bit absolute encoder, the single-turn data is 27 bits and the multi-turn data is 16 bits. Although the combined position information of these is 43 bits wide, the value set in the object as the position information is only 32 bits wide.

Because Obj.6063h:00h “Position actual internal value” sets only the lower 32 bits of the absolute encoder data as positional information, the higher 11 bits of the multi-turn data’s 16 bits are lost, resulting in an effective bit length of 5 bits.

Obj.6064h:00h “Position actual value” calculates position information based on the following formula, resulting in position information that is 32 bits wide. For this reason, the effective bit length of multi-turn data will vary depending on the electronic gear inverse conversion value.

| Obj.607Eh:00h “Polarity” | Position information |
|---|---|
| If 0 (CCW is the positive direction) | 6063h = (M × $2^{27}$ + S) + (37C0h × $2^{27}$ + 37C1h) |
| | 6064h = (6063h × Electronic gear inverse conversion value) + 607Ch |
| If 224 (CW is the positive direction) | 6063h = (M × $2^{27}$ + S) + (37C0h × $2^{27}$ + 37C1h) |
| | 6064h = - (6063h × Electronic gear inverse conversion value) + 607Ch |

* Obj.37C0h:00h “Absolute scale offset1”

* Obj.37C1h:00h “Absolute scale offset2”

* Obj.6063h:00h “Position actual internal value”

- * Obj.6064h:00h “Position actual value”
- * Obj.607Ch:00h “Home offset”
- * M: Multi-turn_Data
- * S: Single-turn_Data

The effective range of multi-turn data can be specified using Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” .

| Pr6.98 bit 3 | Effective range of encoder data [pulse unit] | Actual position data [command unit] (*2) (Obj.6063h × Electronic gear inverse conversion value) | | Effective maximum number of rotations (*1) | Err29.1.0 |
|---|---|---|---|---|---|
| | | Electronic gear ratio | Data range | | |
| 1 | Single-turn data: 27 bit<br>Multi-turn data: 5 bit<br>11 bit Ignore | 1× or more | Actual position data<br>Max. 32 bits | 31<br>(-16 to 15) | Not detected (*4) |
| | | Less than 1× | | Less than 30<br>(Between -15 and 14)<br>Supplement: Dependent upon the electronic gear ratio | Not detected (*4) |
| 0 | Single-turn data: 27 bit<br>Multi-turn data: 16 bit | 2048× or more | Actual position data<br>Max. 32 bits | 65535<br>(-32768 to 32767) | Not detected (*4) |
| | | Less than 2048× | Actual position data<br>Max. 32 bits ▨<br>Err29.1.0 triggered | Less than 65534<br>(Between -32767 and 32766)<br>Supplement: Dependent upon the electronic gear ratio | Detected (*3) |

*1 On the Set-up Support Software (PANATERM ver.7) and EtherCAT, multi-turn data values are displayed as unrestricted information (0 to 65535) in the form of unsigned data (In continuous rotating absolute encoder mode, the value Pr6.88 is the upper limit value displayed.).

Signed data in parentheses ( ) is used for the generated real position [command unit].

- When Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” = 0

  The actual position is calculated within the range of the maximum effective number of rotations with the higher 16 bits of the multi-turn data being effective.

  (Example) Multi-turn data 1 is calculated as 1, 32768 is calculated as -32768, and 65535 is calculated as -1 for the actual position.

- When Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” = 1

  The actual position is calculated within the range of the maximum effective number of rotations by ignoring the higher 11 bits of multi-turn data.

  (Example) Multi-turn data 1 is calculated as 1, 16 is calculated as -16, and 31 is calculated as -1 for the actual position.

  If the value is outside the range of the effective maximum number of rotations (when the higher 11 bits of the multi-turn data are not 0), it will be initialized to the same actual position as when it is within the range of the effective maximum number of rotations (when the higher 11 bits of the multi-turn data are 0).

*2 The value of the actual position calculated from single-turn data, multi-turn data, and electronic gear inverse calculated values must be within a 32-bit width. The host device should not allow position commands to exceed this range.

*3 If the value of the actual position calculated from single-turn data, multi-turn data, and electronic gear inverse converted values exceeds a 32-bit width, Err29.1.0 “Counter overflow protection 1” is triggered.

*4 To rotate infinitely in one direction, set Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” = 0 and the electronic gear ratio to 2048× or more, or Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” = 1 to avoid detecting errors. However, depending on the electronic gear ratio setting, the position at which the actual position exceeds 32 bits and the power turns back on may differ from the position before power was shut off.

Related objects

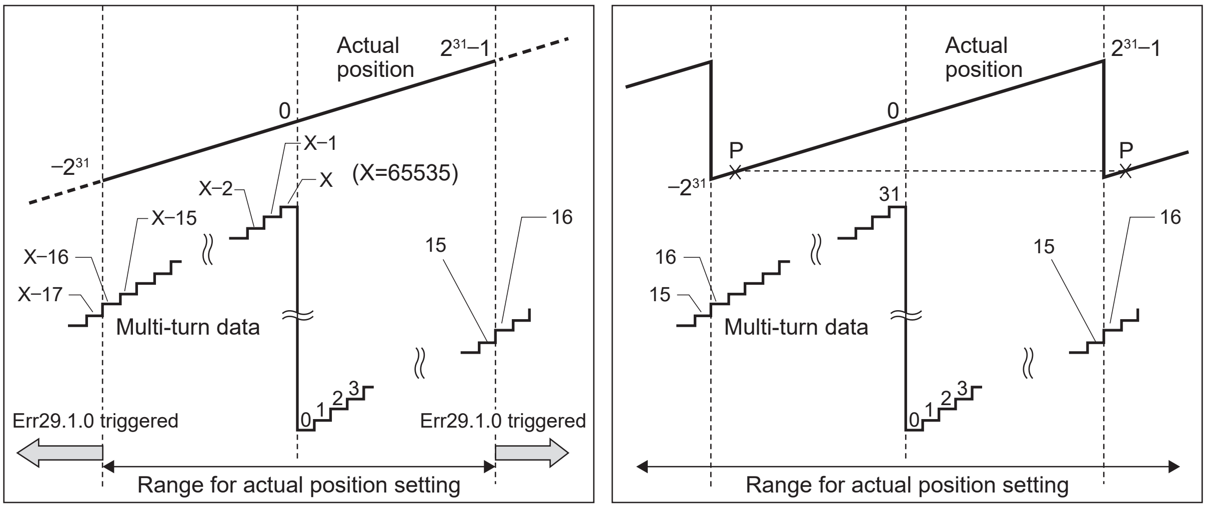
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3698h | 00h | Function expansion setup 4 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | R |
| ● bit 3: Effective bit expansion for multi-turn data<br>0: Enabled (-32768 to 32767 rotations)<br>1: Disabled (-16 to 15 rotations) | | | | | | | | | | |

The following figure shows the difference in the actual position depending on the number of enabled multi-turn bits when the electronic gear ratio is 1×.

3698h:bit 3 = 0

3698h:bit 3 = 1



The location information handled by this product is 32-bit wide data. If absolute encoder position information of 33 bits or more is required, it can be calculated using the following formula.

When using an electronic gear, multiply the reciprocal of the electronic gear ratio by this result.

Obj.4F41h:02h “Multi-turn data” × $2^{27}$ + Obj.4F41h:01h “Mechanical angle (Single-turn data)”

Note that in order to obtain position information, Obj.4F41h:01h “Mechanical angle (Single-turn data)” and Obj.4F41h:02h “Multi-turn data” should be allocated to TxPDO.

Obj.4F41h:01h “Mechanical angle (Single-turn data)” If Obj.4F41h:01h “Mechanical angle (Single-turn data)” and Obj.4F41h:02h “Multi-turn data” are not allocated to TxPDO, read them at the same time in SDO if at all possible.

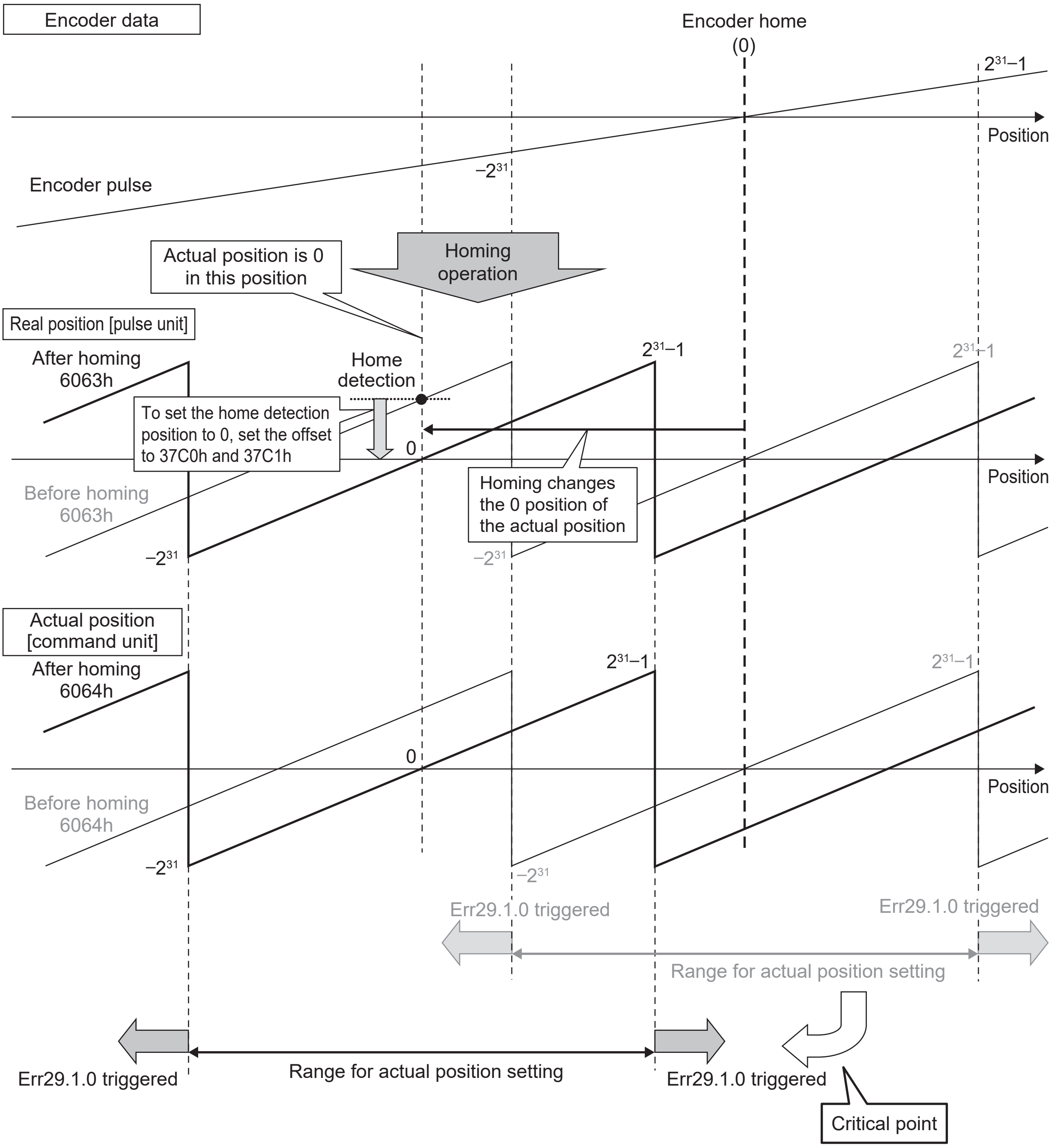
When doing so, there may be a deviation of approximately a single turn in the vicinity of changes to multi-turn data. For this reason, do not use the data that was read in the vicinity of the changes to multi-turn data, but instead use the data read when the motor stops in the vicinity where the single-turn data is approximately $2^{26}$, which is the farthest position.

## ■ Precautions

- Changing the possible setting range for actual position

Electronic gear ratio: 1/1, Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” = 0

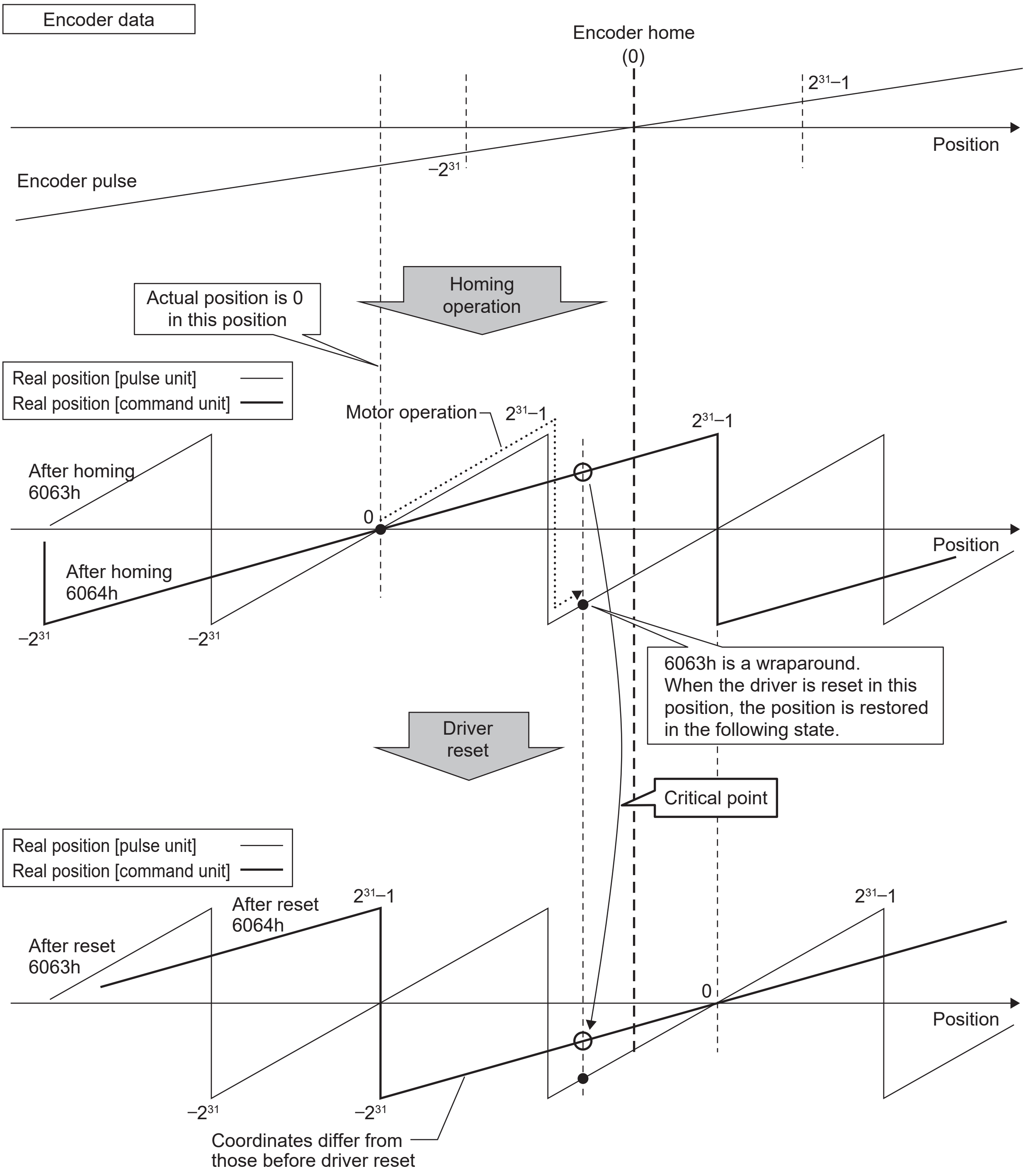
The possible setting range for the actual position and the range in which Err29.1.0 “Counter overflow protection 1” is triggered can also be change in accordance with changes to real position 0 by executing homing (Refer to “Critical point” in the figure below.).



- Changing Obj.6064h:00h “Position actual value” after driver reset

Electronic gear ratio: 2/1, Obj.3698h:00h “Function expansion setup 4” :bit 3 “Effective bit expansion for multi-turn data” = 1

If the electronic gear ratio is not 1/1 and the driver is reset while the actual position [pulse unit] (Obj.6063h:00h “Position actual internal value” ) is a wraparound, the actual position [command unit] (Obj.6064h:00h “Position actual value” ) will change. (Refer to “Critical point” in the figure below.)



## ■ Clearing multi-turn data

Clearing multi-turn data will cause the location of the change to multi-turn data on the CW side of the position where multi-turn data was cleared to become actual position 0.

Because multi-turn data may change intermittently near the location where the multi-turn data changed, clearing the multi-turn data at this time will shift the position of actual position 0 by approximately a single turn depending on the value of the multi-turn data.

To prevent such deviation, clear the data at a position near where the single-turn data, which is the furthest position from the location where the multi-turn data was changed, becomes $2^{26}$.

**— Precautions —**

- When clearing multi-turn data, ensure safety by making sure to leave the servo off and securing it with the brake, etc., if necessary.
- Also leave the servo off during execution and make sure to turn off the control power once execution is complete before turning it on again.

Multi-turn data is cleared via the Set-up Support Software (PANATERM ver.7) or EtherCATcommunication.

Although Err27.1.0 “Absolute clear protection” will be triggered if multi-turn data is cleared via the Set-up Support Software (PANATERM ver.7) , this is only a safety measure and not an error.

Via EtherCAT communication, both Obj.4D00h:01h “Special function start flag 1” and Obj.4D01h:00h “Special function setting 9” can be used to clear multi-turn data.

After setting 0031h to Obj.4D01h:00h “Special function setting 9” , multi-turn data can be cleared by changing Obj.4D00h:01h “Special function start flag 1” :bit 9 from 0 to 1.

When multi-turn data is cleared in the hm control mode, Obj.6041h:00h “Statusword” :bit 12 “homing attained” will be temporarily set to 0.

Once the multi-turn data has been cleared, Obj.6041h:00h “Statusword” :bit 12 “homing attained” returns to 1.

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4D00h</td><td>—</td><td>Special function start</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td></td><td colspan="10">● Executes special functions in accordance with the set value for Obj.4D01h:00h.</td></tr>
<tr><td>4D00h</td><td>00h</td><td>Number of entries</td><td>—</td><td>2</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td></td><td colspan="10">● Displays the number of Obj.4D00h: “Special function start” Sub-Indexes.</td></tr>
<tr><td>4D00h</td><td>01h</td><td>Special function start flag 1</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>B</td></tr>
<tr><td></td><td colspan="10">● bit 9: When the rising edge (0 → 1) of this bit is detected, a special function is executed in accordance with the set value for Obj.4D01h:00h “Special function setting 9” . After this bit is set to 1, it can be returned to 0 at any time.<br>Even if the value is returned to 0 during the execution of a special function, the process being executed will continue.</td></tr>
<tr><td>4D00h</td><td>02h</td><td>Special function start flag 2</td><td>—</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>B</td></tr>
<tr><td></td><td colspan="10">Manufacturer use (Do not change, leave set to the factory default value (0))</td></tr>
<tr><td>4D01h</td><td>00h</td><td>Special function setting 9</td><td>—</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>B</td></tr>
<tr><td></td><td colspan="10">● Set the values in the following table to this object and perform the corresponding special function by starting Obj.4D00h:01h “Special function start flag 1” :bit 9 (change 0 to 1). The value of this object returns to 0000h once the special function has been completed.<br>If Obj.4D00h:01h “Special function start flag 1” :bit 9 is started and an Abort Message appears while the in a state where the multi-turn data cannot be cleared, it will not return to 0000h.
<table>
<tr><th>Value</th><th>Function</th></tr>
<tr><td>0000h</td><td>Nothing happens</td></tr>
<tr><td>0031h</td><td>Absolute encoder multi-turn clear</td></tr>
<tr><td>Other than the above</td><td>Operation indeterminate. Do not set.</td></tr>
</table>
</td></tr>
</table>

**— Precautions —**

- Note the following when clearing multi-turn data via EtherCAT communication.
  - Do so with the servo off.
  - Do not attempt to clear multi-turn data during execution of the touch probe function.
  - Do not attempt to transition the ESM status while clearing multi-turn data.
  - Do not attempt to change the control mode while clearing multi-turn data.

- Do not attempt to clear multi-turn data via the Set-up Support Software (PANATERM ver.7) or refresh the battery while clearing multi-turn data via EtherCAT communication.
- Attempting to clear multi-turn data via EtherCAT communication in the following states will return Abort Message “08000022h”. Ensure that the following states are not present when attempting to clear multi-turn data via EtherCAT communication.
  - Servo-on state
  - Clearing of multi-turn data is in progress (via EtherCAT communication)
  - Clearing of multi-turn data is in progress via the Set-up Support Software (PANATERM ver.7)
  - When using an incremental encoder
  - When the touch probe function is being executed
  - When in single-turn absolute encoder mode (Obj.3015h = 3)

  **Notes**

  - Obj.4D01h:00h “Special function setting 9” will not return a 0 when an Abort Message appears.

- Err27.1.0 “Absolute clear protection” will not be triggered if multi-turn data is cleared via EtherCAT communication.

### 6.6.8.4.5 Position range limit (607Bh)

If the value for Obj.607Ah:00h "Target position" straddles Obj.607Bh: "Position range limit" , wraparound processing will take effect.

Note that the same wraparound processing will also take effect for absolute systems. However, in continuous rotating absolute encoder and in the case of absolute positioning or csp control with pp control, the value at which wraparound occurs will change depending on Obj.3688h:00h "Absolute encoder multi-turn data upper-limit value" and electronic gear settings. Also, setting Obj.607Ah:00h "Target position" outside the range of Obj.607Bh: "Position range limit" will trigger Err91.1.0 "Command error protection" .

**— Precautions —**

- Obj.607Ah:00h "Target position" should be set so as to not exceed the value of Obj.607Bh: "Position range limit" .
- Except in continuous rotating absolute encoder mode, it is treated internally as Obj.607Bh:01h "Min position range limit" = 80000000h and Obj.607Bh:02h "Max position range limit" = 7FFFFFFFh.

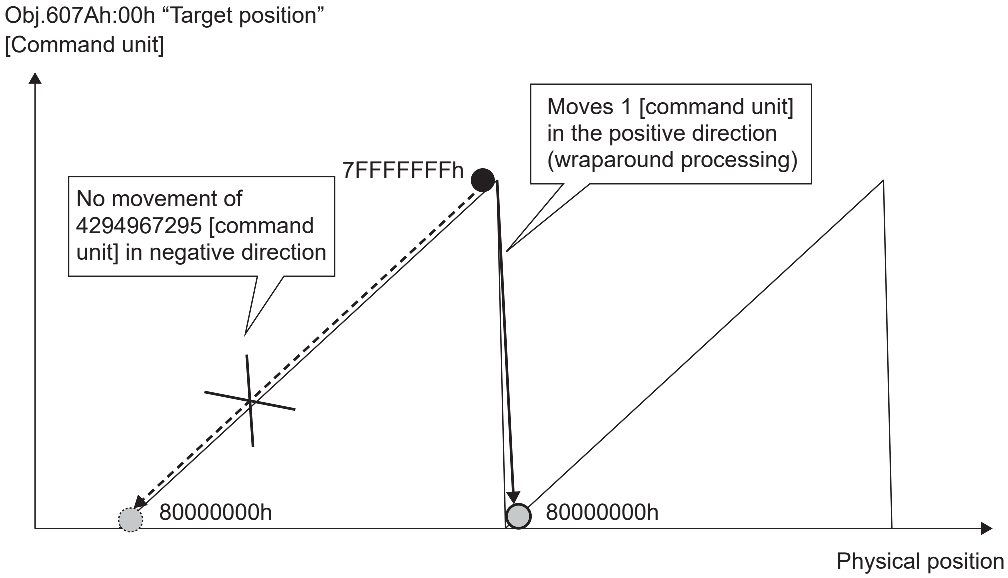
—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Bh | — | Position range limit | — | — | — | — | — | — | — | — |
| | ● Sets the boundary where position coordinates wrap around. | | | | | | | | | |
| 607Bh | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ALL | No | X |
| | ● Displays the number of sub-indexes in Obj.607Bh: "Position range limit" . | | | | | | | | | |
| 607Bh | 01h | Min position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| | ● When position coordinates are below this set value (minimum value), wraparound to the other side of the range (maximum value) occurs.<br>In continuous rotating absolute encoder mode, the value calculated by internal processing is set automatically.<br>Except in continuous rotating absolute encoder mode, it is treated internally as 80000000h (factory default value). | | | | | | | | | |
| 607Bh | 02h | Max position range limit | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | X |
| | ● When position coordinates are above this set value (maximum value), wraparound to the other side of the range (minimum value) occurs.<br>In continuous rotating absolute encoder mode, the value calculated by internal processing is set automatically.<br>Except in continuous rotating absolute encoder mode, it is treated internally as 7FFFFFFFh (factory default value). | | | | | | | | | |

**Example of wraparound**

Obj.607Bh:01h "Min position range limit" = 80000000h

If Obj.607Ah:00h "Target position" changes from 7FFFFFFFh to 80000000h (absolute value movement) when Obj.607Bh:02h "Max position range limit" = 7FFFFFFFh

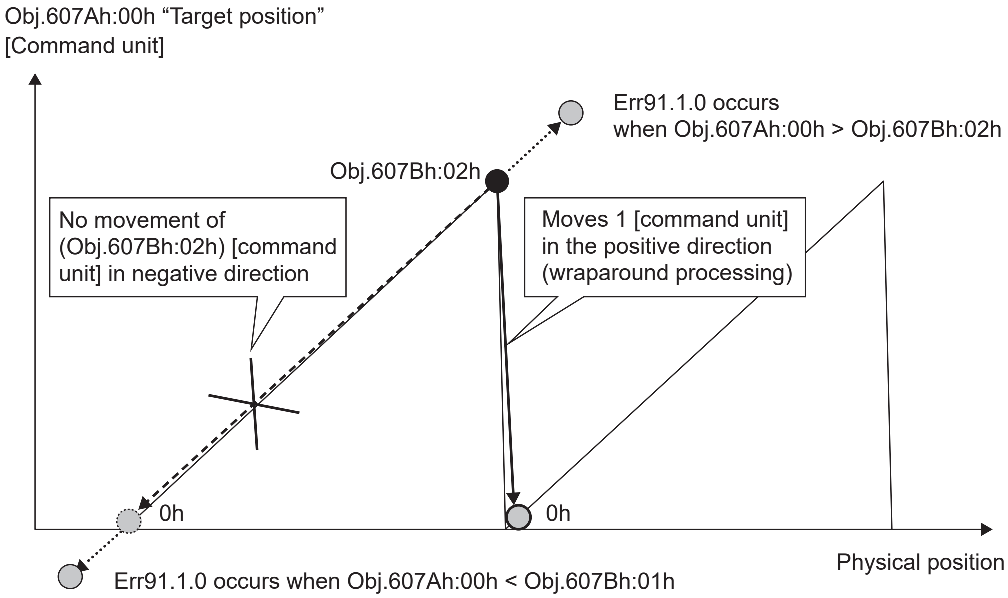


### Example of wraparound (continuous rotating absolute encoder mode)

Obj.607Bh:01h "Min position range limit" = 0h

When Obj.607Bh:02h "Max position range limit" $= \dfrac{2^{27}}{\text{Electronic gear ratio}} \times (3688\text{h} + 1) - 1$,

If Obj.607Ah:00h "Target position" changes from Obj.607Bh:02h "Max position range limit" to Obj.607Bh:01h "Min position range limit" (absolute value movement)



### 6.6.8.4.6 Home offset (607Ch)

Although this object can be updated at any time, the actual position information will be reflected at the following times.

(Example) When the electronic gear ratio is 1/1 and there is no polarity reversal

- When control power is turned on
- When communication is established (when ESM state transitions from Init → PreOP)
- When homing is completed
- When clearing of multi-turn data via the Set-up Support Software (PANATERM ver.7) and EtherCAT
- When the Set-up Support Software (PANATERM ver.7) function (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) ends
- When Config is executed by Set-up Support Software (PANATERM ver.7)
- When Err27.4.0 “Position command error protection” occurs

The following objects are initialized (preset) based on the position at the above time.

- When the home position is detected

  Obj.6063h:00h “Position actual internal value” = Obj.60FCh:00h “Position demand internal value” = 0

  Obj.6062h:00h “Position demand value” = Obj.6064h:00h “Position actual value” = Obj.607Ch:00h “Home offset”
- During initialization to “presets” at times other than when the home position is detected

  Obj.6063h:00h “Position actual internal value” = Obj.60FCh:00h “Position demand internal value”

  Obj.6062h:00h “Position demand value” = Obj.6064h:00h “Position actual value” = Obj.6063h:00h “Position actual internal value” + Obj.607Ch:00h “Home offset”

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes | P<br>H |

- After completing the execution of homing position control mode (hm), the position information is set so that the detected Index Pulse position functions as the value for this object.

  The value of this object will also be added to the position information at the following times.
  - When control power is turned on
  - When communication is established (when ESM state transitions from Init → PreOP)
  - When homing is completed
  - When clearing of multi-turn data via the Set-up Support Software (PANATERM ver.7) and EtherCAT
  - When the Set-up Support Software (PANATERM ver.7) function (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) ends
  - When Config is executed by Set-up Support Software (PANATERM ver.7)
- When Err27.4.0 “Position command error protection” occurs

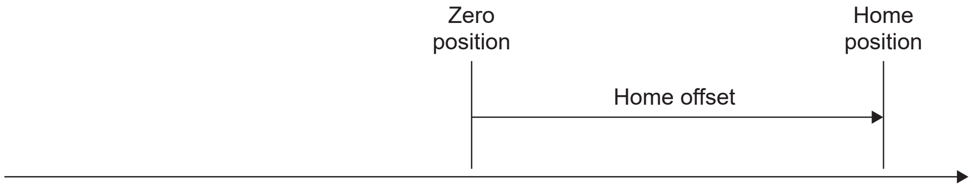
**— Precautions —**

- Position information will be preset when homing is performed. For this reason, data acquired using the old coordinate system (e.g., Touch probe position) must be reacquired.

- For an incremental system

  Home position: Position detected as home

  Zero position: 0 (the position when control power-is turned on or the position obtained by subtracting the Home offset from the Home position detected by hm)



<Home offset definition>

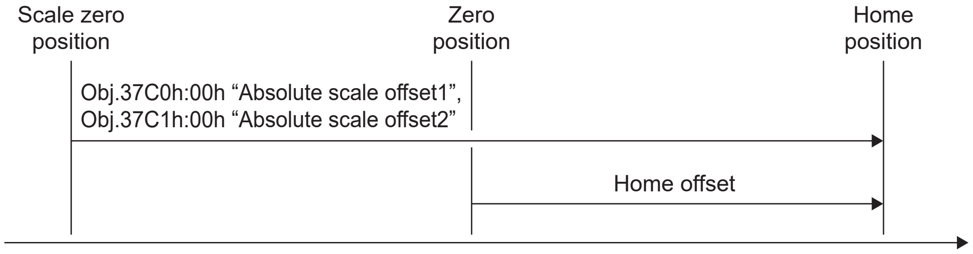
- For an absolute system

  Home position: Position detected as home

  Zero position: The position obtained by subtracting the home offset from the home position detected by hm

  Scale zero position, in semi-closed control: Zero position of the absolute encoder

  Scale zero position, in full-closed control: Zero position of absolute external scale or the home position minus Obj.37C0h and Obj.37C1h



<Home offset definition>

### 6.6.8.4.7 Initialization of Absolute Scale (During Full-closed Control)

#### ■ Absolute data

The absolute scale position information during full-closed control is 48 bits wide, which consists of the lower 24 bits and higher 24 bits of external scale position data. However, the value set in the object as the position information is 32 bits wide.

Because Obj.6063h:00h "Position actual internal value" sets only the lower 32 bits of the absolute scale data as position information, only the lower 8 bits of the higher 24-bit data are effective.

Obj.6064h:00h "Position actual value" calculates position information based on the following formula, resulting in position information that is 32 bits wide.

For this reason, the effective bit length of the external scale position information data during full-closed control will vary depending on the electronic gear inverse conversion value.

In full-closed control, Err29.1.0 "Counter overflow protection 1" is generated when the calculated value of $(((H \times 2^{24} + L) + (37C0h \times 2^{24} + 37C1h)) \times$ electronic gear inverse conversion value) exceeds a width of 32 bits, or when an overflow occurs in the process of the above calculation.

| 607Eh "Polarity" | Maximum effective bit length of H | Position Information |
|---|---|---|
| 0<br>(No sign inversion) | 8 bits | Obj.6063h = $(H \times 2^{24} + L) + (Obj.37C0h \times 2^{24} + Obj.37C1h)$ |
| | 21 bits | Obj.6064h = $((( H \times 2^{24} + L + (Obj.37C0h \times 2^{24} + Obj.37C1h)) \times$ Electronic gear inverse conversion value) + Obj.607Ch |
| 224<br>(Sign inversion) | 8 bits | Obj.6063h = $(H \times 2^{24} + L) + (Obj.37C0h \times 2^{24} + Obj.37C1h)$ |
| | 21 bits | Obj.6064h = $-((((H \times 2^{24} + L) + (Obj.37C0h \times 2^{24} + Obj.37C1h)) \times$ Electronic gear inverse conversion value)) + Obj.607Ch |

H: External scale data (Higher 24 bit)

L: External scale data (Lower 24 bit)

Obj.37C0h:00h "Absolute scale offset1" Position information in which the H sign is inverted during homing

Obj.37C1h:00h "Absolute scale offset2" Position information in which the L sign is inverted during homing

Obj.6063h:00h "Position actual internal value"

Obj.6064h:00h "Position actual value"

Obj.607Ch:00h "Home offset"

#### ■ Clearing multi-turn data

Multi-turn data can be cleared when using the full-closed control function on a rotary scale. For clearing multi-turn data, see *"6.6.8.4.4 Initialization of Absolute Encoder (During Semi-closed Control)"* .

### 6.6.8.4.8 Backlash Compensation Function

Obj.3704h:00h “Backlash compensation enable” , Obj.3705h:00h “Backlash compensation value” , and Obj.3706h:00h “Constant for backlash compensation” can compensate for backlash (mechanical clearance between the driving axis and the driven axis) during position control (including full-closed control).

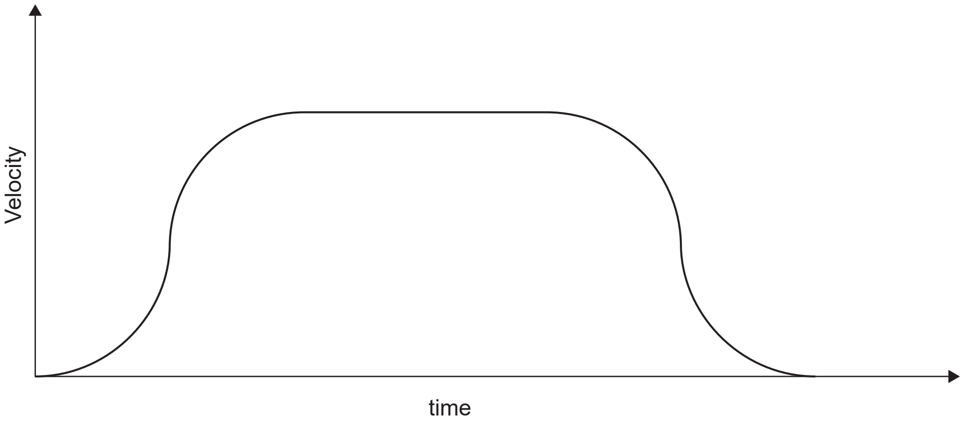
Although the feedback position during backlash compensation returns a value that is the result of removing the amount of backlash compensation after backlash has been corrected, the amount of backlash compensation appears in the transient state during backlash compensation.

#### 6.6.8.5 Jerk (Not Supported)

Jerk is not supported by this software version.

Set Obj.6086h:00h “Motion profile type” , Obj.60A4h:01h “Profile jerk1” , and Obj.60A4h:02h “Profile jerk2” to 0, and Obj.60A3h:00h “Profile jerk use” to 1.

Setting jerk can smooth switching between acceleration and deceleration.



<Velocity/time diagram with jerk positions>

This function is not supported and cannot be used, but smoothing can also be achieved using Obj.3222h:00h “Positional command smoothing filter” and Obj.3223h:00h “Positional command FIR filter” .

### 6.6.8.6 Interpolation Time Period (60C2h)

Obj.60C2h: “Interpolation time period” is automatically set according to the communication cycle as shown in the table below and should not be changed.

| Communication cycle | Obj.60C2h:01h | Obj.60C2h:02h |
|---|---|---|
| 62.5 μs | 62 | -6 |
| 125 μs | 125 | -6 |
| 250 μs | 25 | -5 |
| 500 μs | 5 | -4 |
| 1 ms | 1 | -3 |
| 2 ms | 2 | -3 |
| 4 ms | 4 | -3 |
| 8 ms | 8 | -3 |
| 10 ms | 1 | -2 |

**— Precautions —**

- If the communication cycle is operating at 62.5 μs, 60C2h:01h is set to 62 instead of 62.5.

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 60C2h | — | Interpolation time period | — | — | — | — | — | — | — | — |
| | ● Sets the interpolation time cycle. | | | | | | | | | |
| 60C2h | 00h | Highest sub-index supported | — | 2 | U8 | ro | No | ip<br>csp<br>csv<br>cst | No | X |
| | ● Displays the number of sub-indexes in Obj.60C2h: “Interpolation time period” . | | | | | | | | | |
| 60C2h | 01h | Interpolation time period value | — | 0 to 255 | U8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| | ● Sets the interpolation time cycle.<br>This is automatically set according to the communication cycle. | | | | | | | | | |
| 60C2h | 02h | Interpolation time index | — | -128 to 63 | I8 | rw | No | ip<br>csp<br>csv<br>cst | Yes | A |
| | ● Sets the interpolation time index.<br>This is automatically set according to the communication cycle. | | | | | | | | | |

### 6.6.8.7 Servo Information Monitoring Object

This object is used to monitor the information retained by this product.

—: N/A

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4308h</td><td>00h</td><td>History number</td><td>—</td><td>0 to 3</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>A</td></tr>
<tr><td colspan="11">● Selects the alarm supplementary information to be displayed using Obj.4DA0h: “Alarm accessory information” .<br>If set to 0, supplementary information for the current alarm is displayed.<br>When set to 1 to 3, supplementary information for 1 to 3 alarms ago is displayed.<br>(Alarms with attributes that do not remain in the history are not eligible as past alarms.)</td></tr>
<tr><td>430Eh</td><td>—</td><td>Timestamp reference time</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="11">● Sets the reference time for timestamping used by the timestamping function. For details on the timestamping function, see “10.4 Timestamp Function” .<br>The reference time for timestamping should be set to the elapsed time in ns units, starting at 0:00:0:0 on January 1, 2000.<br>(Example) April 1, 2023, 0:00:00:00<br>Sets 0A2E59AF97450000h (=733622400000000000).<br>The reference time for timestamping is reflected internally by the product using the following procedure.<br>1 The reference time for timestamping is set as 64-bit data and sent to this product by SDO. Of the 64-bit data, the lower 32 bits are set using Obj.430Eh:01h “Timestamp reference time setting 1” , while the higher 32 bits are set using Obj.430Eh:02h “Timestamp reference time setting 2” .<br>2 Change Obj.60FEh: “Digital outputs” Obj.60FEh:01h “Physical outputs” :bit 28 “Timestamp reference time reset” from 0 to 1 with PDO. The set values of 430Eh:01h and 430Eh:02h sent to this product are reflected inside the servo driver when 60FEh:01h:bit 28 changes from 0 to 1. If synchronizing multiple axes, changes to Obj.60FEh: “Digital outputs” Obj.60FEh:01h “Physical outputs” :bit 28 “Timestamp reference time reset” must be made for all axes simultaneously. Accordingly, changes to 60FEh:01h:bit 28 should be made in DC synchronous mode or SM2 synchronous mode and with the ESM status set to OP.<br>The reference time for timestamping will not be set in this product when 60FEh:01h:bit 28 is changed from 0 to 1 and the reference time for timestamping has not been set at 430Eh:01h and 430Eh:02h, or when 60FEh:01h:bit 28 is not changed from 0 to 1 (the reference time for timestamping has not been updated in this product). In such a case, the time for timestamping would be as follows.<br>• In DC synchronous mode, the product reads the Distributed Clock from the ESC and uses it as the time for timestamping.<br>• In modes other than DC synchronous mode, the time for timestamping is fixed at 0000000000000000h (January 1, 2000, 0:00:00:00).</td></tr>
<tr><td>430Eh</td><td>00h</td><td>Number of entries</td><td>—</td><td>2</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the number of Obj.430Eh: “Timestamp reference time” Sub-Indexes.</td></tr>
<tr><td>430Eh</td><td>01h</td><td>Timestamp reference time setting 1</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>A</td></tr>
<tr><td colspan="11">● Sets the lower 32 bits of the reference time for timestamping.<br>Sets bits 0 to 31 of the elapsed time in ns units, with January 1, 2000 0:00:0:0 as 0.<br>(Example) For April 1, 2023, 0:00:00:00 (733622400 seconds have elapsed since January 1, 2000, 0:00:00:00)<br>Because 0A2E59AF97450000h (=733622400000000000) is bits 0 to 31, set 97450000h (=2537881600).</td></tr>
<tr><td>430Eh</td><td>02h</td><td>Timestamp reference time setting 2</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>A</td></tr>
<tr><td colspan="11">● Sets the higher 32 bits of the reference time for timestamping.<br>Sets bits 32 to 63 of the elapsed time in ns units, with January 1, 2000 0:00:0:0 as 0.<br>(Example) For April 1, 2023, 0:00:00:00 (733622400 seconds have elapsed since January 1, 2000, 0:00:00:00)<br>Because 0A2E59AF97450000h (=733622400000000000) is bits 32 to 63, set 0A2E59AFh (=170809775).</td></tr>
</table>

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4310h</td><td>00h</td><td>Alarm main no</td><td>—</td><td>0 to 127</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>A</td></tr>
<tr><td colspan="11">● Alarm sub-number information for the alarm main number set in Obj.4310h:00h “Alarm main no” is displayed in Obj.4F37h:10h “Multiple sub alarm information” .<br>Furthermore, alarm primary cause number information for alarms that correspond to the combination of the alarm main numbers set in Obj.4310h:00h “Alarm main no” and alarm sub-numbers set in Obj.4317h:00h “Alarm sub no” is displayed in Obj.4F37h:20h “Multiple alarm cause information 1” to Obj.4F37h:23h “Multiple alarm cause information 4” .</td></tr>
<tr><td>4317h</td><td>00h</td><td>Alarm sub no</td><td>—</td><td>0 to 127</td><td>U8</td><td>rw</td><td>No</td><td>ALL</td><td>No</td><td>A</td></tr>
<tr><td colspan="11">● For details, see Obj.4310h:00h “Alarm main no” .</td></tr>
<tr><td>4D0Eh</td><td>—</td><td>Expansion warning flags</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="11">● Displays flags indicating the status of currently triggered warnings.</td></tr>
<tr><td>4D0Eh</td><td>00h</td><td>Number of entries</td><td>—</td><td>3</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the number of Obj.4D0Eh: “Expansion warning flags” Sub-Indexes.</td></tr>
<tr><td>4D0Eh</td><td>01h</td><td>Expansion warning flags 1</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays flags indicating the status of currently triggered warnings.<br>Bit assignments are as follows.</td></tr>
</table>

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | Battery warning |
| 1 | — |
| 2 | Lifetime detection warning |
| 3 | Encoder overheat warning |
| 4 | Encoder communication warning |
| 5 | Over-regeneration warning |
| 6 | Fan lock warning |
| 7 | Motor overload warning |
| 8 | External scale error warning |
| 9 | — |
| ⋮ | |
| 11 | |
| 12 | Main power off warning |

| bit | Warning flag |
|---|---|
| 13 | Oscillation detection warning |
| 14 | External scale communication warning |
| 15 | — |
| ⋮ | |
| 23 | |
| 24 | Set-up Support Software (PANATERM ver.7) command execution warning |
| 25 | Over-travel inhibit warning |
| 26 | — |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D0Eh | 02h | Expansion warning flags 2 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays flags indicating the status of currently triggered warnings.
  Bit assignments are as follows.

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | — |
| ⁝ | |
| 7 | |
| 8 | Main power phase loss warning |
| 9 | Fan speed reduction warning |
| 10 | Driver overload warning |
| 11 | Lifetime detection warning 2 |
| 12 | — |
| ⁝ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D0Eh | 03h | Expansion warning flags 3 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays flags indicating the status of currently triggered warnings.
  Bit assignments are as follows.

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | — |
| ⁝ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D10h | — | External scale ID | — | — | — | — | — | — | — | — |

- Displays the external scale ID.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D10h | 00h | Number of entries | — | 2 | U8 | ro | No | ALL | No | X |

- Displays the number of sub-indexes in Obj.4D10h: “External scale ID” .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D10h | 01h | External scale vendor ID | — | — | VS | ro | No | ALL | No | X |

- Displays the external scale vendor ID.
  One byte NULL is appended at the end. The size of this object is 2 bytes.
  3: Mitutoyo Corporation
  4: Magnescale Co., Ltd.
  5: Common ID (Panasonic communication specifications)

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D10h | 02h | External scale model ID | — | — | VS | ro | No | ALL | No | X |

- Displays the external scale model ID.
  One byte NULL is appended at the end. The size of this object is 2 bytes.

| Vendor name | Model ID | Absolute/ Incremental |
|---|---|---|
| Mitutoyo Corporation | 1 | Absolute |
| | 2 | Absolute (Electromagnetic induction type) |
| | 3 | Incremental |
| Magnescale Co., Ltd. | 1 | Absolute |
| | 2 | Incremental |
| | 3 | Incremental (Laser scale) |
| Common ID (Panasonic communication specifications) | 1 | Absolute |
| | 2 | Incremental |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D12h | 00h | Motor serial number | — | — | VS | ro | No | ALL | No | X |

- Displays the motor serial number (Max. 8 characters).
  Two byte NULL is appended at the end. The size of this object is 10 bytes.
  (Example) “17040021”

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D15h | 00h | Drive serial number | — | — | VS | ro | No | ALL | No | X |

- Displays the driver serial number (Max. 8 characters).
  A NULL occupies 2 bytes at the end. The size of this object is 10 bytes.
  (Example) “17100001”

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D29h | 00h | Over load factor | 0.1% | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the overload load factor (ratio of motor rated load).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D51h | 00h | Analog input status | — | 0 to 65535 | U16 | ro | TxPDO | csp | No | X |

- Displays the setting status Obj.4351h:00h “Analog input function” .
  Bit 0: Setting status of position compensation function switching
   0: Position compensation disabled
   1: Position correction enabled

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4D57h | 00h | Driver derating monitor | % | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |

- Displays the ratio of driver overload warnings to the warning trigger level.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | — | Alarm accessory information | — | — | — | — | — | — | — | — |

- Displays supplementary information for the alarm specified by Obj.4308h:00h “History number” .
  - When Obj.4308h:00h “History number” = 0, supplementary information for the current alarm is displayed.
  - When Obj.4308h:00h “History number” = 1 to 3, supplementary information for 1 to 3 alarms ago is displayed.

**— Precautions —**

- Obj.4DA0h: “Alarm accessory information” does not support PDO.
- Each sub-index of Obj.4DA0h: “Alarm accessory information” is read by SDO so synchronism cannot be guaranteed.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | 00h | Number of entries | — | 71 | U8 | ro | No | ALL | No | X |

- Displays the number of sub-indexes in Obj.4DA0h: “Alarm accessory information” .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | 01h | History number echo | – | 0 to 3 | U8 | ro | No | ALL | No | X |
| | | ● Displays the echo back of the history number set in Obj.4308h:00h “History number” . | | | | | | | | |
| 4DA0h | 02h | Alarm code | – | 0 to 4294967295 | U32 | ro | No | ALL | No | X |
| | | ● Displays the alarm number.<br>bits 7 to 0: Alarm sub-numbers<br>bits 14 to 8: Alarm main numbers<br>bits 31 to 15: Manufacturer use | | | | | | | | |
| 4DA0h | 03h | Control mode | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the control mode.<br>0: Position control mode<br>1: Velocity control mode<br>2: Torque control mode<br>3: Full-closed control mode | | | | | | | | |
| 4DA0h | 04h | Motor speed | r/min | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the motor speed. | | | | | | | | |
| 4DA0h | 05h | Positional command velocity | r/min | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the position command speed. | | | | | | | | |
| 4DA0h | 06h | Velocity control command | r/min | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the velocity control command. | | | | | | | | |
| 4DA0h | 07h | Torque command | 0.05% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the torque command. | | | | | | | | |
| 4DA0h | 08h | Position command deviation | Command unit | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the position command deviation. | | | | | | | | |
| 4DA0h | 09h | Position actual internal value | pulse | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the motor position. | | | | | | | | |
| 4DA0h | 0Bh | Input port (logic signal) | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays input ports (logical signals). | | | | | | | | |
| 4DA0h | 0Ch | Output port (logic signal) | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays output ports (logical signals). | | | | | | | | |
| 4DA0h | 0Dh | Analog input | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays analog inputs. | | | | | | | | |
| 4DA0h | 10h | Overload ratio | 0.2 % | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the overload load factor. | | | | | | | | |
| 4DA0h | 11h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the regenerative load factor. | | | | | | | | |
| 4DA0h | 12h | Voltage across PN | V | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the voltage across P and N. | | | | | | | | |
| 4DA0h | 13h | Temperature of amplifier | °C | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the driver temperature. | | | | | | | | |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4DA0h</td><td>14h</td><td>Warning flags</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">
● Displays warning flags.<br>Bit assignments are as follows.<br>—: No assignment
<table>
<tr><th>bit</th><th>Warning flag</th></tr>
<tr><td>0</td><td>Battery warning</td></tr>
<tr><td>1</td><td>—</td></tr>
<tr><td>2</td><td>Lifetime detection warning</td></tr>
<tr><td>3</td><td>Encoder overheat warning</td></tr>
<tr><td>4</td><td>Encoder communication warning</td></tr>
<tr><td>5</td><td>Over-regeneration warning</td></tr>
<tr><td>6</td><td>Fan lock warning</td></tr>
<tr><td>7</td><td>Motor overload warning</td></tr>
<tr><td>8</td><td>External scale error warning</td></tr>
<tr><td>9</td><td>—</td></tr>
<tr><td>10</td><td>—</td></tr>
</table>
<table>
<tr><th>bit</th><th>Warning flag</th></tr>
<tr><td>11</td><td>—</td></tr>
<tr><td>12</td><td>Main power off warning</td></tr>
<tr><td>13</td><td>Oscillation detection warning</td></tr>
<tr><td>14</td><td>External scale communication warning</td></tr>
<tr><td>15</td><td rowspan="3">—</td></tr>
<tr><td>⋮</td></tr>
<tr><td>31</td></tr>
</table>
</td></tr>
<tr><td>4DA0h</td><td>15h</td><td>Inertia ratio</td><td>%</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the inertia ratio.</td></tr>
<tr><td>4DA0h</td><td>19h</td><td>Temperature of encoder</td><td>°C</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the encoder temperature.</td></tr>
<tr><td>4DA0h</td><td>1Dh</td><td>U-phase current detection value</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the U-phase current detection value.</td></tr>
<tr><td>4DA0h</td><td>1Eh</td><td>W-phase current detection value</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the W-phase current detection value.</td></tr>
<tr><td>4DA0h</td><td>21h</td><td>Encoder single-turn data</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays encoder single-turn data.</td></tr>
<tr><td>4DA0h</td><td>22h</td><td>Encoder communication error count (accumulated)</td><td>Inciden-ces</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the cumulative number of successive encoder communication errors.</td></tr>
<tr><td>4DA0h</td><td>23h</td><td>External scale communication data error count (accumulated)</td><td>Inciden-ces</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the cumulative number of successive external scale communication errors.</td></tr>
</table>

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4DA0h</td><td>25h</td><td>Alarm occurrence time on timestamp standard (Lower)</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the lower 32 bits at the time an alarm is triggered. The displayed value changes depending whether the set reference time for timestamping has been applied to this product and on the synchronization mode. For information on how the set reference time for timestamping is applied to this product, see the explanation for Obj.430Eh: “Timestamp reference time” in *“6.6.8.7 Servo Information Monitoring Object”* .<br>• If the alarm was triggered after the set reference time for timestamping was applied to this product, bits 0 to 31 of the elapsed time from the reference time for timestamping are displayed.<br>• If the alarm was triggered in DC synchronous mode and before the set reference time for timestamping was applied to this product, the product displays bits 0 to 31 of the Distributed Clock time read from the ESC.<br>• If the alarm was triggered in a mode other than DC synchronous mode and before the set reference time for timestamping was applied to this product, the data to be read is fixed at 0.</td></tr>
<tr><td>4DA0h</td><td>26h</td><td>Alarm occurrence time on timestamp standard (Higher)</td><td>ns</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the higher 32 bits at the time an alarm is triggered. The displayed value changes depending whether the set reference time for timestamping has been applied to this product and on the synchronization mode. For information on how the set reference time for timestamping is applied to this product, see the explanation for Obj.430Eh: “Timestamp reference time” in *“6.6.8.7 Servo Information Monitoring Object”* .<br>• If the alarm was triggered after the set reference time for timestamping was applied to this product, bits 32 to 63 of the elapsed time from the reference time for timestamping are displayed.<br>• If the alarm was triggered in DC synchronous mode and before the set reference time for timestamping was applied to this product, the product displays bits 32 to 63 of the Distributed Clock time read from the ESC.<br>• If the alarm was triggered in a mode other than DC synchronous mode and before the set reference time for timestamping was applied to this product, the data to be read is fixed at 0.</td></tr>
<tr><td>4DA0h</td><td>27h</td><td>Alarm occurrence time on power on time</td><td>0.5 h</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the total time of control power energization of the servo driver when an alarm is detected.</td></tr>
<tr><td>4DA0h</td><td>28h</td><td>Alarm occurrence time on power on time (detail)</td><td>62.5 μs</td><td>0 to 4294967295</td><td>U32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Out of the total time of control power energization of the servo driver when an alarm is detected, this displays amounts of time less than 30 minutes that are not displayed by Obj.4DA0h:27h “Alarm occurrence time on power on time” .</td></tr>
<tr><td>4DA0h</td><td>2Ah</td><td>Alarm code (extended)</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the extended alarm number.<br>bits 7 to 0: Manufacturer use<br>bits 15 to 8: Alarm cause numbers<br>bits 23 to 16: Alarm sub-numbers<br>bits 31 to 24: Alarm main numbers</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | 2Bh | Warning flags1 | — | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays warning flag 1.
  Bit assignments are as follows.

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | Battery warning |
| 1 | — |
| 2 | Lifetime detection warning |
| 3 | Encoder overheat warning |
| 4 | Encoder communication warning |
| 5 | Over-regeneration warning |
| 6 | Fan lock warning |
| 7 | Motor overload warning |
| 8 | External scale error warning |
| 9 | — |
| ⋮ | |
| 11 | |

| bit | Warning flag |
|---|---|
| 12 | Main power off warning |
| 13 | Oscillation detection warning |
| 14 | External scale communication warning |
| 15 | — |
| ⋮ | |
| 23 | |
| 24 | Set-up Support Software (PANATERM ver.7) command execution warning |
| 25 | Over-travel inhibit warning |
| 26 | — |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | 2Ch | Warning flags2 | — | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays warning flag 2.
  Bit assignments are as follows.

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | — |
| ⋮ | |
| 7 | |
| 8 | Main power phase loss warning |
| 9 | Fan speed reduction warning |
| 10 | Driver overload warning |
| 11 | Lifetime detection warning 2 |
| 12 | — |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4DA0h | 2Dh | Warning flags3 | — | 0 to 4294967295 | U32 | ro | No | ALL | No | X |

- Displays warning flag 3.
  Bit assignments are as follows.

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | — |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F01h | 00h | Following error actual value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | • Displays position deviation (after filter). | | | | | | | | | |
| 4F03h | 00h | Analog input internal voltage | mV | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the level of the applied voltage (after offset and filter) of the analog input. | | | | | | | | | |
| 4F04h | 00h | Position command internal value (after filtering) | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | • Displays the internal command position (after filter). | | | | | | | | | |
| 4F0Ch | 00h | Velocity command value (after filtering) | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | • Displays command speed (after filter).<br>**Notes**<br>• Returns the same value as Obj.4FA5h:00h “Velocity internal position command” .<br>• If monitoring, use Obj.4FA5h. | | | | | | | | | |
| 4F0Dh | 00h | External scale position | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays position information for the external scale. | | | | | | | | | |
| 4F11h | 00h | Regenerative load ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | • Displays the regenerative load factor (the ratio of regenerative overload protection to the level of alarm occurrence). | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F21h | 00h | Logical input signal | – | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays the logical level status of the input signal.
  Bit assignments are as follows.

–: No assignment

| bit | Input signal logical level status |
|---|---|
| 0 | – |
| 1 | External alarm clear input (A-CLR) |
| 2 | Negative direction over-travel inhibit input (NOT) |
| 3 | Positive direction over-travel inhibit input (POT) |
| 4 | – |
| 5 | – |
| 6 | – |
| 7 | Forced alarm input (E-STOP) |
| 8 | – |
| ⋮ | |
| 26 | |
| 27 | Safety input 1 (SF1) (*1) |
| 28 | Safety input 2 (SF2) (*1) |
| 29 | – |
| 30 | – |
| 31 | Dynamic brake switching input (DB-SEL) |

*1 Within 100 ms after the safety input turns from OFF to ON, there are times at which the self-diagnosis function turns OFF max. 6 times for 5 ms. Note that acquiring the logical level status during this period may result in acquiring an OFF status due to the diagnostic signal.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F22h | 00h | Logical output signal | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays the logical level status of the output signal.
  Bit assignments are as follows.

—: No assignment

| bit | Output signal logical level status |
|---|---|
| 0 | Servo-ready output (S-RDY) |
| 1 | Servo alarm output (ALM) |
| 2 | Positioning complete output (INP) |
| 3 | Brake release output (BRK-OFF) |
| 4 | Zero-speed detection output (ZSP) |
| 5 | Output during torque limitation (TLC) |
| 6 | Velocity coincidence output (V-COIN) |
| 7 | — |
| 8 | — |
| 9 | Speed arrival output (AT-SPEED) |
| 10 | Deterioration diagnosis velocity output (V-DIAG) |
| 11 | — |
| ⋮ | |
| 14 | |

| bit | Output signal logical level status |
|---|---|
| 15 | Servo-on export (SRV-ST) (*1) |
| 16 | Warning output 1 (WARN1) |
| 17 | Warning output 2 (WARN2) |
| 18 | Position command ON/OFF output (P-CMD) |
| 19 | Positioning complete output 2 (INP2) |
| 20 | Output during velocity limit (V-LIMIT) |
| 21 | Alarm clear attribute output (ALM-ATB) |
| 22 | Speed command ON/OFF output (V-CMD) |
| 23 | EDM output (EDM) |
| 24 | General-purpose output (EX-OUT1) |
| 25 | — |
| ⋮ | |
| 29 | |
| 30 | STO status monitor output (STO) (*2) |
| 31 | — |

*1 Indicates servo-on status if 0, and servo-off status if 1.

*2 The STO status monitoring output signal is not safety-related.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F23h | 00h | Logical input signal (expansion portion) | — | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays the logical level status of the input signal (extended portion).
  Bit assignments are as follows.

—: No assignment

| bit | Input signal logical level status |
|---|---|
| 0 | External latch input 1 (EXT1) |
| 1 | External latch input 2 (EXT2) |
| 2 | — |
| 3 | — |
| 4 | Near home input (HOME) |
| 5 | — |
| ⋮ | |
| 12 | |
| 13 | Retracting operation input (RET) |

| bit | Input signal logical level status |
|---|---|
| 14 | — |
| ⋮ | |
| 17 | |
| 18 | General-purpose monitor input 1 (SI-MON1) |
| 19 | General-purpose monitor input 2 (SI-MON2) |
| 20 | General-purpose monitor input 3 (SI-MON3) |
| 21 | General-purpose monitor input 4 (SI-MON4) |
| 22 | General-purpose monitor input 5 (SI-MON5) |
| 23 | — |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F25h | 00h | Physical input signal | – | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays the physical level status of the input signal.
  Bit assignments are as follows.

–: No assignment

| bit | Input signal physical level status |
|---|---|
| 0 | SI1 input |
| 1 | SI2 input |
| 2 | SI3 input |
| 3 | SI4 input |
| 4 | SI5 input |
| 5 | SI6 input |
| 6 | SI7 input |
| 7 | SI8 input |
| 8 | – |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F26h | 00h | Physical output signal | – | 0 to 4294967295 | U32 | ro | TxPDO | ALL | No | X |

- Displays the physical level status of the output signal.
  Bit assignments are as follows.

–: No assignment

| bit | Output signal physical level status |
|---|---|
| 0 | SO1 output |
| 1 | SO2 output |
| 2 | SO3 output |
| 3 | – |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F31h | 00h | Inertia ratio | % | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |

- Displays the inertia ratio.
  Ratio of load inertia to motor rotor inertia (equivalent to the value in Obj.3004h)
  Inertia ratio: (load inertia/rotor inertia) × 100

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F32h | 00h | Motor automatic identification | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays the motor automatic recognition enable status.
  255: Automatic recognition enabled
  Other than 255: Automatic recognition disabled

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F33h | 00h | Cause of motor no work | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays a number indicating the cause of the motor being inoperative.

| Cause No. (*1) | Item | Description (*2) |
|---|---|---|
| 0 | No cause | The cause of inoperation could not be detected. Operation would normally be possible in this state. |
| 1 | The servo is not in ready status. | ● The main power supply of the driver is off, or an error occurred.<br>● Communication and servo synchronization are incomplete.<br>This includes other cases in which the servo ready signal is off. |
| 2 | The servo-on command is off. | The servo-on command is off.<br>● The PDS status is not operation enabled.<br>Etc. |
| 3 | Over-travel inhibit input is enabled. | When Pr5.04 “Over-travel inhibit input setup” = 0, 1 (over-travel inhibit input enabled)<br>● Positive direction over-travel inhibit input (POT) is on and the motion command is positive direction.<br>● Negative direction over-travel inhibit input (NOT) is on and the motion command is negative direction.<br>When Pr5.04 “Over-travel inhibit input setup” = 2 (alarm triggered at over-travel inhibit input)<br>● The positive direction over-travel inhibit input (POT) or negative direction over-travel inhibit input (NOT) is turned on regardless of whether there is operation command input. |
| 4 | The torque limit setting is low | The enabled torque limit set value is set to 5% or less of the rating. |
| 7 | The position command input frequency is low | The position command per control cycle is one command unit or less. |
| 10 | The command speed from EtherCAT communication is low | The command speed from EtherCAT communication is set to 30 r/min or less. |
| 11 | Manufacturer use | — |
| 12 | The command torque from EtherCAT communication is small | The command torque from the EtherCAT communication is small as it is 5% or less of the rated torque. |
| 13 | The velocity limit is small | The velocity limit of Obj.6080h:00h “Max motor speed” is set to 30 r/min or less. |
| 14 | Other causes | Causes 1 to 13 do not apply and the motor is not rotating (Low command, heavy load/locking/collision, driver/motor failure, etc.). |

*1 The motor may operate even if the read value is a number other than 0.

*2 Note that there are some exceptional detections, such as when over-travel inhibit input stops the position command generation process, resulting in cause 7 instead of cause 3.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F34h | 00h | Warning flags | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays flags indicating the status of currently triggered warnings.

  Bit assignments are as follows.

—: No assignment

| bit | Warning flag |
|---|---|
| 0 | Battery warning |
| 1 | — |
| 2 | Lifetime detection warning |
| 3 | Encoder overheat warning |
| 4 | Encoder communication warning |
| 5 | Over-regeneration warning |
| 6 | Fan lock warning |
| 7 | Motor overload warning |
| 8 | External scale error warning |

| bit | Warning flag |
|---|---|
| 9 | — |
| ⋮ | |
| 11 | |
| 12 | Main power off warning |
| 13 | Oscillation detection warning |
| 14 | External scale communication warning |
| 15 | — |
| ⋮ | |
| 22 | |

| bit | Warning flag |
|---|---|
| 23 | — |
| 24 | Set-up Support Software (PANATERM ver.7) command execution warning |
| 25 | Over-travel inhibit warning |
| 26 | — |
| ⋮ | |
| 31 | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | — | Multiple alarm/warning information | — | — | — | — | — | — | — | — |

- Displays the currently triggered alarm and warning information in the corresponding bit.

  The following is a procedure for reading alarms. When reading alarm numbers, acquire the main number first, and then the sub number.

  (Example) When reading alarm information with Err26.1.0 “2nd Overspeed protection” and Err38.0.0 “Over-travel inhibit input protection 1” triggered at the same time

  1 Alarm information for alarm main numbers 0 to 31 are acquired by Obj.4F37h:01h “Multiple alarm information 1” .

  1 is returned for bit 26 because the corresponding alarm, Err26.1.0 “2nd Overspeed protection” , has been triggered. This result indicates that an alarm main number 26 error has been triggered.

  2 Alarm information for alarm main numbers 32 to 63 are acquired by Obj.4F37h:02h “Multiple alarm information 2” .

  1 is returned for bit 6 because the corresponding alarm, Err38.0.0 “Over-travel inhibit input protection 1” , has been triggered. This result indicates that an alarm main number 38 error has been triggered.

  3 Alarm information for alarm main numbers 64 to 95 are acquired by Obj.4F37h:03h “Multiple alarm information 3” .

  Because no corresponding alarm is triggered, 0 is returned.

  4 Alarm information for alarm main numbers 96 to 127 are acquired by Obj.4F37h:04h “Multiple alarm information 4” .

  Because no corresponding alarm is triggered, 0 is returned.

  5 Sets the main alarm number 26 that is being triggered to Obj.4310h:00h “Alarm main no” , and acquires the alarm sub-number of alarm main number 26 from Obj.4F37h:10h “Multiple sub alarm information” .

  Because Err26.1.0 “2nd Overspeed protection” was triggered, 1 is returned for bit 1. This result indicates that an alarm sub-number 1 error has been triggered.

  6 Sets the main alarm number 38 that is being triggered to Obj.4310h:00h “Alarm main no” , and acquires the alarm sub-number of alarm main number 38 from Obj.4F37h:10h “Multiple sub alarm information” .

  Because Err38.0.0 “Over-travel inhibit input protection 1” was triggered, 1 is returned for bit 0. This result indicates that an alarm sub-number 1 error has been triggered.

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 00h | Number of entries | — | 35 | U8 | ro | No | ALL | No | X |

- Displays the number of sub-indexes in Obj.4F37h: “Multiple alarm/warning information” .

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 01h | Multiple alarm information 1 | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays alarm information for alarm main numbers 0 to 31.
  Bit assignments are as follows. Non-existent alarm numbers are also shown.

| bit | Alarm main number |
|---|---|
| 0 | Err0.□.□ |
| 1 | Err1.□.□ |
| 2 | Err2.□.□ |
| ⋮ | ⋮ |
| 29 | Err29.□.□ |
| 30 | Err30.□.□ |
| 31 | Err31.□.□ |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 02h | Multiple alarm information 2 | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays alarm information for alarm main numbers 32 to 63.
  Bit assignments are as follows. Non-existent alarm numbers are also shown.

| bit | Alarm main number |
|---|---|
| 0 | Err32.□.□ |
| 1 | Err33.□.□ |
| 2 | Err34.□.□ |
| ⋮ | ⋮ |
| 29 | Err61.□.□ |
| 30 | Err62.□.□ |
| 31 | Err63.□.□ |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 03h | Multiple alarm information 3 | – | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays alarm information for alarm main numbers 64 to 95.
  Bit assignments are as follows. Non-existent alarm numbers are also shown.

| bit | Alarm main number |
|---|---|
| 0 | Err64.□.□ |
| 1 | Err65.□.□ |
| 2 | Err66.□.□ |
| ⋮ | ⋮ |
| 29 | Err93.□.□ |
| 30 | Err94.□.□ |
| 31 | Err95.□.□ |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 04h | Multiple alarm information 4 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays alarm information for alarm main numbers 96 to 127.
  Bit assignments are as follows. Non-existent alarm numbers are also shown.

| bit | Alarm main number |
|---|---|
| 0 | Err96.□.□ |
| 1 | Err97.□.□ |
| 2 | Err98.□.□ |
| ⋮ | ⋮ |
| 29 | Err125.□.□ |
| 30 | Err126.□.□ |
| 31 | Err127.□.□ |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 10h | Multiple sub alarm information | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays alarm information for the sub-numbers of alarm main numbers set by Obj.4310h:00h “Alarm main no” .
  Bit assignments are as follows. Non-existent alarm numbers are also shown.

| bit | Alarm sub-number |
|---|---|
| 0 | Err□.0.□ |
| 1 | Err□.1.□ |
| 2 | Err□.2.□ |
| ⋮ | ⋮ |
| 29 | Err□.29.□ |
| 30 | Err□.30.□ |
| 31 | Err□.31.□ |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 11h | Multiple warning information 1 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays warning information for warning numbers A0h to BFh.
  Bit assignments are as follows. Non-existent warning numbers are also shown.

| bit | Warning No. |
|---|---|
| 0 | WngA0h |
| 1 | WngA1h |
| 2 | WngA2h |
| 3 | WngA3h |
| 4 | WngA4h |
| 5 | WngA5h |
| 6 | WngA6h |
| 7 | WngA7h |

| bit | Warning No. |
|---|---|
| 8 | WngA8h |
| 9 | WngA9h |
| 10 | WngAAh |
| 11 | WngABh |
| 12 | WngACh |
| 13 | WngADh |
| 14 | WngAEh |
| 15 | WngAFh |

| bit | Warning No. |
|---|---|
| 16 | WngB0h |
| 17 | WngB1h |
| 18 | WngB2h |
| 19 | WngB3h |
| 20 | WngB4h |
| 21 | WngB5h |
| 22 | WngB6h |
| 23 | WngB7h |

| bit | Warning No. |
|---|---|
| 24 | WngB8h |
| 25 | WngB9h |
| 26 | WngBAh |
| 27 | WngBBh |
| 28 | WngBCh |
| 29 | WngBDh |
| 30 | WngBEh |
| 31 | WngBFh |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 12h | Multiple warning information 2 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays warning information for warning numbers C0h to DFh.
  Bit assignments are as follows. Non-existent warning numbers are also shown.

| bit | Warning No. | bit | Warning No. | bit | Warning No. | bit | Warning No. |
|---|---|---|---|---|---|---|---|
| 0 | WngC0h | 8 | WngC8h | 16 | WngD0h | 24 | WngD8h |
| 1 | WngC1h | 9 | WngC9h | 17 | WngD1h | 25 | WngD9h |
| 2 | WngC2h | 10 | WngCAh | 18 | WngD2h | 26 | WngDAh |
| 3 | WngC3h | 11 | WngCBh | 19 | WngD3h | 27 | WngDBh |
| 4 | WngC4h | 12 | WngCCh | 20 | WngD4h | 28 | WngDCh |
| 5 | WngC5h | 13 | WngCDh | 21 | WngD5h | 29 | WngDDh |
| 6 | WngC6h | 14 | WngCEh | 22 | WngD6h | 30 | WngDEh |
| 7 | WngC7h | 15 | WngCFh | 23 | WngD7h | 31 | WngDFh |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 13h | Multiple warning information 3 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Displays warning information for warning numbers E0h to FFh.
  Bit assignments are as follows. Non-existent warning numbers are also shown.

| bit | Warning No. | bit | Warning No. | bit | Warning No. | bit | Warning No. |
|---|---|---|---|---|---|---|---|
| 0 | WngE0h | 8 | WngE8h | 16 | WngF0h | 24 | WngF8h |
| 1 | WngE1h | 9 | WngE9h | 17 | WngF1h | 25 | WngF9h |
| 2 | WngE2h | 10 | WngEAh | 18 | WngF2h | 26 | WngFAh |
| 3 | WngE3h | 11 | WngEBh | 19 | WngF3h | 27 | WngFBh |
| 4 | WngE4h | 12 | WngECh | 20 | WngF4h | 28 | WngFCh |
| 5 | WngE5h | 13 | WngEDh | 21 | WngF5h | 29 | WngFDh |
| 6 | WngE6h | 14 | WngEEh | 22 | WngF6h | 30 | WngFEh |
| 7 | WngE7h | 15 | WngEFh | 23 | WngF7h | 31 | WngFFh |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F37h | 20h | Multiple alarm cause information 1 | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |

- Alarm cause number information for alarms that correspond to the combination of the alarm main numbers set in Obj.4310h:00h “Alarm main no” and alarm sub-numbers set in Obj.4317h:00h “Alarm sub no” is displayed.

| bit | Alarm Cause No. |
|---|---|
| 0 | Err□.□.0 |
| 1 | Err□.□.1 |
| ⋮ | ⋮ |
| 31 | Err□.□.31 |

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th><th>Attribute</th></tr>
<tr><td>4F37h</td><td>21h</td><td>Multiple alarm cause information 2</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Alarm cause number information for alarms that correspond to the combination of the alarm main numbers set in Obj.4310h:00h “Alarm main no” and alarm sub-numbers set in Obj.4317h:00h “Alarm sub no” is displayed.
<table>
<tr><th>bit</th><th>Alarm Cause No.</th></tr>
<tr><td>0</td><td>Err□.□.32</td></tr>
<tr><td>1</td><td>Err□.□.33</td></tr>
<tr><td>⋮</td><td>⋮</td></tr>
<tr><td>31</td><td>Err□.□.63</td></tr>
</table></td></tr>
<tr><td>4F37h</td><td>22h</td><td>Multiple alarm cause information 3</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Alarm cause number information for alarms that correspond to the combination of the alarm main numbers set in Obj.4310h:00h “Alarm main no” and alarm sub-numbers set in Obj.4317h:00h “Alarm sub no” is displayed.
<table>
<tr><th>bit</th><th>Alarm Cause No.</th></tr>
<tr><td>0</td><td>Err□.□.64</td></tr>
<tr><td>1</td><td>Err□.□.65</td></tr>
<tr><td>⋮</td><td>⋮</td></tr>
<tr><td>31</td><td>Err□.□.95</td></tr>
</table></td></tr>
<tr><td>4F37h</td><td>23h</td><td>Multiple alarm cause information 4</td><td>—</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Alarm cause number information for alarms that correspond to the combination of the alarm main numbers set in Obj.4310h:00h “Alarm main no” and alarm sub-numbers set in Obj.4317h:00h “Alarm sub no” is displayed.
<table>
<tr><th>bit</th><th>Alarm Cause No.</th></tr>
<tr><td>0</td><td>Err□.□.96</td></tr>
<tr><td>1</td><td>Err□.□.97</td></tr>
<tr><td>⋮</td><td>⋮</td></tr>
<tr><td>31</td><td>Err□.□.127</td></tr>
</table></td></tr>
<tr><td>4F41h</td><td>—</td><td>Motor encoder data</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="11">● Displays position information.</td></tr>
<tr><td>4F41h</td><td>00h</td><td>Number of entries</td><td>—</td><td>2</td><td>U8</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the number of sub-indexes in Obj.4F41h: “Motor encoder data” .</td></tr>
<tr><td>4F41h</td><td>01h</td><td>Mechanical angle (Single-turn data)</td><td>pulse</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO<br>(*1)</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the motor mechanical angle (encoder single-turn data).</td></tr>
<tr><td>4F41h</td><td>02h</td><td>Multi-turn data</td><td>Rotation</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>TxPDO<br>(*1)</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays multi-turn data of the absolute encoder.<br>Notes<br>● Multi-turn data is undefined in increment mode (Obj.3015h:00h “Absolute encoder setup” = 1).</td></tr>
<tr><td>4F42h</td><td>00h</td><td>Electrical angle</td><td>0.0879°</td><td>-2147483648 to 2147483647</td><td>I32</td><td>ro</td><td>No</td><td>ALL</td><td>No</td><td>X</td></tr>
<tr><td colspan="11">● Displays the electrical angle of the motor.</td></tr>
</table>

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F44h | 00h | Encoder status | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the encoder status. | | | | | | | | | |
| 4F48h | 00h | External scale pulse total | Pulse (external scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the external scale pulse sum. | | | | | | | | | |
| 4F49h | 00h | External scale absolute position | Pulse (external scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the absolute position of the external scale. | | | | | | | | | |
| 4F4Ah | 00h | External scale position deviation | Pulse (external scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | ● Displays the full-closed deviation. | | | | | | | | | |
| 4F4Fh | 00h | Analog input value | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | csp | No | X |
| | ● Displays the position compensation value according to the voltage applied to the analog input. | | | | | | | | | |
| 4F61h | 00h | Power on cumulative time | 30 minutes | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the total time of control power energization of this product. | | | | | | | | | |
| 4F62h | 00h | Temperature of amplifier | °C | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the product’s internal temperature. | | | | | | | | | |
| 4F63h (*1) | 00h | Temperature of encoder | °C | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the encoder’s internal temperature. | | | | | | | | | |
| 4F64h | 00h | Inrush resistance relay operating count | Incidences | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the number of times the relay for inrush current suppression resistance changes.<br>Saturates at a maximum value of 40000000h.<br>Because recording takes place in 30-minute increments, adding will not take place if the control power is shut off before the recording time has elapsed. | | | | | | | | | |
| 4F65h | 00h | Dynamic brake operating count | Incidences | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the number of times the relay for the dynamic brake changes.<br>Saturates at a maximum value of 40000000h.<br>Because recording takes place in 30-minute increments, adding will not take place if the control power is shut off before the recording time has elapsed. | | | | | | | | | |
| 4F66h | 00h | Fan operating time | 30 minutes | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the operating time of the cooling fan.<br>Because recording takes place in 30-minute increments, adding will not take place if the control power is shut off before the recording time has elapsed.<br>Displayed as 0 if no fan is installed. | | | | | | | | | |
| 4F67h | 00h | Fan life expectancy | 0.1% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the ratio of cooling fan service life with full as 100%.<br>Because recording takes place in 30-minute increments, adding will not take place if the control power is shut off before the recording time has elapsed.<br>Displayed as 0 if no fan is installed. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F68h | 00h | Capacitor life expectancy | 0.1% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the ratio of main power capacitor service life with full as 100%.<br>Because recording takes place in 30-minute increments, adding will not take place if the control power is shut off before the recording time has elapsed. | | | | | | | | | |
| 4F6Ch | 00h | Motor power consumption | W | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays motor power consumption. | | | | | | | | | |
| 4F6Dh | 00h | Amount of motor power consumption | Wh | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the amount of motor power consumption. | | | | | | | | | |
| 4F6Eh | 00h | Cumulative value of motor power consumption | Wh | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the integrated amount of motor power consumption.<br>Saturates at a maximum value of 2147483647.<br>Because recording takes place in 30-minute increments, adding will not take place if the control power is shut off before the recording time has elapsed. | | | | | | | | | |
| 4F77h | 00h | Lost link error count | Incidences | 0 to 65535 | U16 | ro | No | ALL | No | X |
| | ● Displays the lost link count. | | | | | | | | | |
| 4F78h | 00h | Synchronization signal error count | Incidences | 0 to 65535 | U16 | ro | No | ALL | No | X |
| | ● Displays the number of consecutive synchronization or IRQ errors. | | | | | | | | | |
| 4F81h | 00h | Encoder communication error count (accumulated) | Incidences | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | ● Displays the cumulative number of encoder communication errors.<br>Saturates at a maximum value of FFFFh.<br>It is cleared when this product is rebooted or the control power is reset. | | | | | | | | | |
| 4F83h | 00h | External scale communication error count (accumulated) | Incidences | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | ● Displays the cumulative number of external scale communication errors.<br>Saturates at a maximum value of FFFFh.<br>It is cleared when this product is rebooted or the control power is reset. | | | | | | | | | |
| 4F84h | 00h | External scale communication data error count (accumulated) | Incidences | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | ● Displays the cumulative number of external scale communication data errors.<br>Saturates at a maximum value of FFFFh.<br>It is cleared when this product is rebooted or the control power is reset. | | | | | | | | | |
| 4F86h | 00h | Hybrid deviation | Command unit | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | ● Displays the hybrid deviation. | | | | | | | | | |
| 4F87h | 00h | External scale data (Higher) | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the upper 24 bits of the external scale data. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4F88h | 00h | External scale data (Lower) | pulse<br>(External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the lower 24 bits of the external scale data. | | | | | | | | | |
| 4F89h | 00h | External scale status | — | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | ● Displays external scale status. | | | | | | | | | |
| 4F8Ah | 00h | External scale Z phase counter | — | 0 to 65535 | U16 | ro | No | ALL | No | X |
| | ● Displays the Z-phase counter value read from the external scale in 0 to F [hex] when the incremental external scale is used in full-closed control or semi-closed control with the external scale position information monitoring function enabled. | | | | | | | | | |
| 4F8Ch | 00h | External scale single-turn data | pulse | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays external scale single-turn data. | | | | | | | | | |
| 4F91h | 00h | Estimation accuracy of magnetic pole position | Degrees | 0 to 180 | U8 | ro | TxPDO | ALL | No | X |
| | ● Displays the estimation accuracy (electrical angle: 0 to 180 degrees) when estimating the magnetic pole position.<br>Because this object is not supported by the standard type, multi-function type, or application specialized type, it always returns 0. | | | | | | | | | |
| 4F92h | 00h | Execution time of estimation of magnetic pole position | ms | 0 to 65535 | U16 | ro | TxPDO | ALL | No | X |
| | ● Displays the execution time for magnetic pole position estimation.<br>Because this object is not supported by the standard type, multi-function type, or application specialized type, it always returns 0. | | | | | | | | | |
| 4F93h | 00h | Maximum travel distance to plus direction when estimating magnetic pole position | pulse<br>(Feedback scale unit) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Returns the maximum amount of movement in the positive direction based on the start position for executing magnetic pole position estimation.<br>Because this object is not supported by the standard type, multi-function type, or application specialized type, it always returns 0. | | | | | | | | | |
| 4F94h | 00h | Maximum travel distance to minus direction when estimating magnetic pole position | pulse<br>(Feedback scale unit) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Returns the maximum amount of movement in the negative direction based on the start position for executing magnetic pole position estimation.<br>Because this object is not supported by the standard type, multi-function type, or application specialized type, it always returns 0. | | | | | | | | | |
| 4FA1h | 00h | Velocity command value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | ● Displays the velocity control command. | | | | | | | | | |
| 4FA5h | 00h | Velocity internal position command | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | ● Displays the internal position command speed. | | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FA6h | 00h | Velocity error actual value | r/min | -2147483648 to 2147483647 | I32 | ro | TxPDO | pp<br>hm<br>csp | No | X |
| | | ● Displays the speed deviation. Displays 0 when using full-closed control. | | | | | | | | |
| 4FA7h | 00h | External scale position (Applied polarity) | pulse (External scale) | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the external scale position (after Polarity is applied). | | | | | | | | |
| 4FA8h | 00h | Positive direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the positive direction. | | | | | | | | |
| 4FA9h | 00h | Negative direction torque limit value | 0.05% | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the torque limit value in the negative direction. | | | | | | | | |
| 4FABh | 00h | Gain switching flag | — | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the gain switching flag.<br>0: 1st gain section<br>1: 2nd gain section<br>3: 3rd gain section | | | | | | | | |
| 4FB1h | 00h | Deterioration diagnosis state | — | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis status.<br>bit 0: Deterioration diagnosis warning enabled<br>bit 1: Load characteristic estimation enabled<br>bit 2: Load characteristic estimation convergence complete<br>bit 3: Deterioration diagnosis velocity output<br>bit 4: Deterioration diagnosis torque average time elapsed<br>bit 5: Deterioration diagnosis warning cause (torque command average value)<br>bit 6: Deterioration diagnosis warning cause (inertia ratio)<br>bit 7: Deterioration diagnosis warning cause (unbalanced load)<br>bit 8: Deterioration diagnosis warning cause (dynamic friction)<br>bit 9: Deterioration diagnosis warning cause (viscous friction) | | | | | | | | |
| 4FB2h | 00h | Deterioration diagnosis torque command average value | 0.1% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis torque command average value. | | | | | | | | |
| 4FB3h | 00h | Deterioration diagnosis torque command standard value | 0.1% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis torque command standard deviation. | | | | | | | | |
| 4FB4h | 00h | Deterioration diagnosis inertia ratio estimate value | % | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis inertia ratio estimation. | | | | | | | | |
| 4FB5h | 00h | Deterioration diagnosis offset load estimate value | 0.1% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis unbalanced load estimation. | | | | | | | | |

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 4FB6h | 00h | Deterioration diagnosis dynamic friction estimate value | 0.1% | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis dynamic friction estimation. | | | | | | | | |
| 4FB7h | 00h | Deterioration diagnosis viscous friction estimate value | 0.1 %/ (10000 r/ min) | -2147483648 to 2147483647 | I32 | ro | No | ALL | No | X |
| | | ● Displays the deterioration diagnosis viscous friction estimation. | | | | | | | | |
| 4FC2h | 00h | Analog input voltage | mV | -2147483648 to 2147483647 | I32 | ro | TxPDO | ALL | No | X |
| | | ● Displays the level of the applied voltage (before offset) of the analog input. | | | | | | | | |
| 6403h | 00h | Motor catalogue number | — | — | VS | ro | No | ALL | No | X |
| | | ● Displays the motor part no. | | | | | | | | |

*1 Only 27-bit encoders are supported. When not supported, it is set to 0.

# 7 Basic Functions

## 7.1 Startup Operation

This section describes control signal input timing from after control power supply is turned on until a command is input.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Power supply is off |

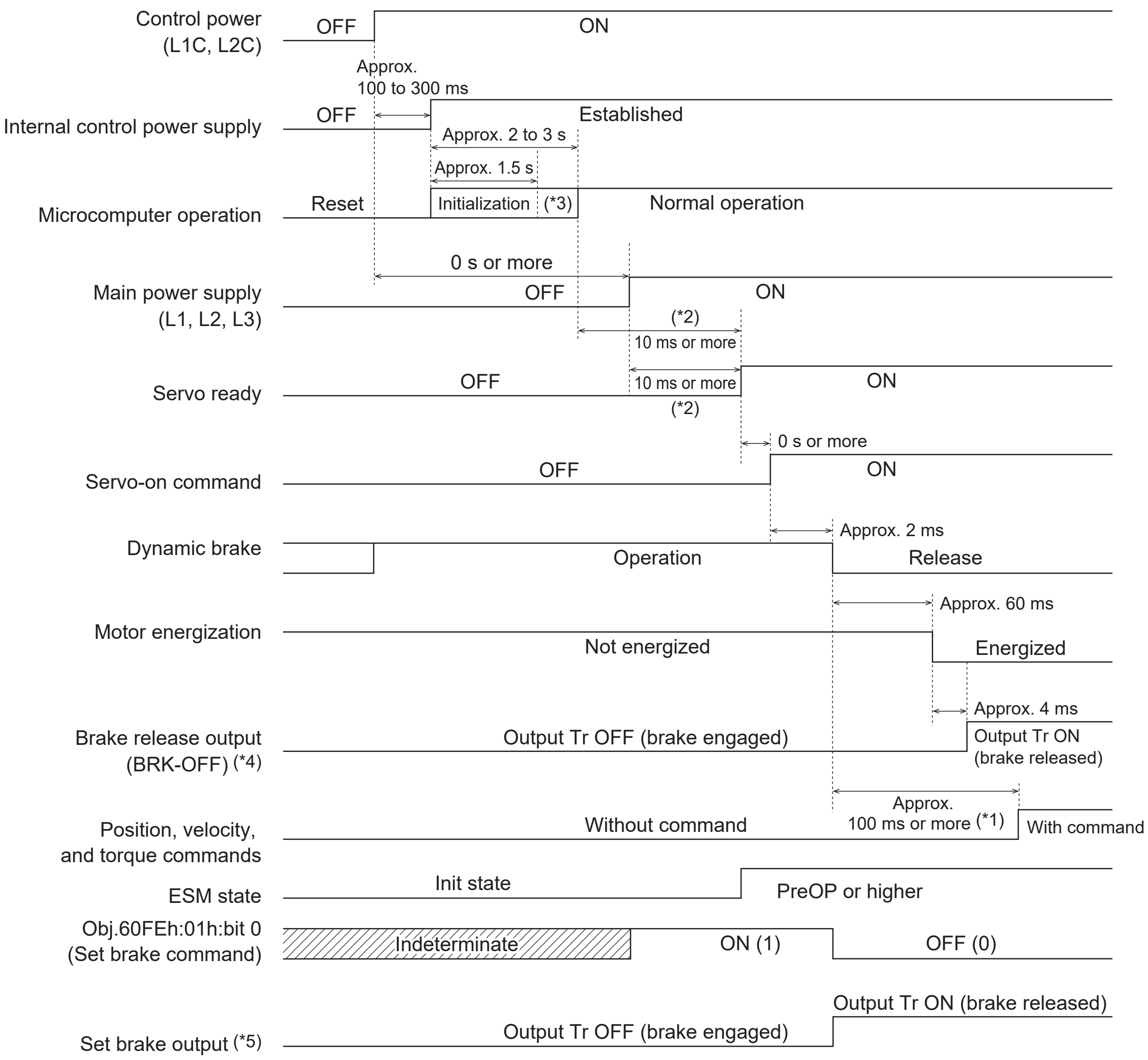
### ■ Setup value

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 18 | R | Power-up wait time | 0 to 100 | 0.1 s | Sets the initialization time after power-on to a standard time of approx. 1.5 s + α (set value × 0.1 s).<br>For example, with a set value of 10, 1.5 s + (10 × 0.1 s) = approx. 2.5 s. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Operation

Input servo-on command, and position, velocity, and torque commands according to the timing in the following chart.



*1 This period is not ready to receive position, speed, or torque command input. Command input should be made after this period is completed.

*2 Servo ready turns on when all of the following conditions are met: the microcomputer is initialized, main power supply is established, no alarms have been triggered, and EtherCAT communication has been established.

*3 Once internal control power supply is established, the protection function starts running approx.1.5 s after microcomputer initialization begins. Configure so that all input/output signals connected to the servo driver (especially those that can trigger the protection function, such as positive direction/negative direction over-travel inhibit input, external scale input) are confirmed before the protection function begins operating. The time between the start of microcontroller initialization and the start of protection function operation can be increased at Pr6.18 “Power-up wait time” .

*4 The brake release output (BRK-OFF) is different from the Obj.60FEh: “Digital outputs” set brake command from EtherCAT communication.

*5 The set brake output is controlled by the set brake command of Obj.60FEh: “Digital outputs” from EtherCAT communication. For details on the set brake command from Obj.60FEh: “Digital outputs” , see *“6.6.8.3.2 Digital outputs (60FEh)”* .

As the brake can also be released when in servo-off state, be mindful of safety issues when controlling the set brake output.

## ■ Precautions

Before turning on the power, check the wiring, the power supply voltage, and that the motor is connected correctly.

## 7.2 Control Mode Common Functions

### 7.2.1 Rotational Direction Setting

A function that sets motor rotational direction (polarity) relative to the command direction.

#### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

#### ■ Setup value

None (MINAS A7B Series does not support setting the direction of rotation via Pr0.00 “Rotational direction setup” )

#### ■ Related objects

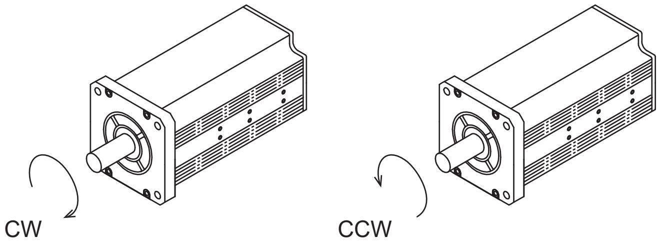
In the MINAS A7B Series, rotational direction is set using Obj.607Eh:00h “Polarity” as prescribed in CoE (CiA402).

For details on Obj.607Eh:00h “Polarity” , see *“6.6.8.4.3 Polarity (607Eh)”* .

—: N/A

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 607Eh | 00h | Polarity | — | 0 to 255 | U8 | rw | No | ALL | Yes | P, H |

- The motor rotational direction, when viewed from the load side axis end, is defined as CW when clockwise and CCW when counterclockwise.



- Sets the polarity for when transferring position commands, speed commands, torque commands, position offsets, speed offsets (added speed) and torque offsets (added torque) values from objects to the internal processing, and for when transferring position feedback, speed feedback and torque feedback values from the internal processing to objects.

| Setup value | Description |
|---|---|
| 0 | ● No position, velocity or torque sign inversion<br>The rotational direction of the motor for positive direction commands is CCW. |
| 224 | ● With position, velocity or torque sign inversion<br>The rotational direction of the motor for positive direction commands is CW. |
| Other than the above | ● Not supported (do not attempt to configure settings) |

### 7.2.2 Command Input Processing

This process sets the control mode by inputting commands through the EtherCAT communication objects.

In position control and full-closed control, the commands perform position command input, in velocity control, speed command input, and in torque control, torque command input.

For more information on communication objects, see below.

- *"6.6.5 Position Control Function (pp, csp, ip, hm)"*
- *"6.6.6 Velocity Control Function (pv, csv)"*
- *"6.6.7 Torque Control Function (tq, cst)"*

Control mode is forcibly switched inside this product according to its operation status, regardless of commands from the host device. Because this operation also affects input signal assignments, it is generally recommended to assign the same function to each terminal in all modes.

The conditions for forcibly switching control modes are shown below.

| Operation status if this product | Control mode after forced switching |
|---|---|
| When using Set-up Support Software (PANATERM ver.7) to perform frequency characteristics analysis | ● During position loop characteristics analysis: Position control<br>● During velocity closed-loop characteristics analysis: Velocity control<br>● During torque speed (automatic) analysis: Position control<br>● During torque speed (vertical) analysis: Velocity control<br>● During torque speed (normal) analysis: Torque control |
| During trial run via Set-up Support Software (PANATERM ver.7) | ● Position control |
| Operations with descriptions of "forcible position control" using various deceleration to stop functions ( *"8.12"* to *"8.15"* ) | ● Position control |
| During retracting operations | ● Position control |

### 7.2.3 Electronic Gear Function

The electronic gear is a function that sets a value obtained by multiplying a position and speed command input from a host device by an electronic gear ratio set in an object as a position and speed command to a position and velocity controller.

This function can be used to set motor rotation and movement amounts arbitrarily on a per-command-unit basis.

For details, see *“6.6.8.4.2 Electronic Gear Function”* .

#### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

#### ■ Setup value

In the MINAS A7B Series, the electronic gear ratios are set by Obj.608Fh: “Position encoder resolution” , Obj.6091h: “Gear ratio” , and Obj.6092h: “Feed constant” as specified in the CoE (CiA402).

The relationship between user-defined units (command units) and internal units [pulse] is calculated using the following equation.

$$\text{Electronic gear ratio} = \frac{\text{Position encoder resolution} \times \text{Gear ratio}}{\text{Feed constant}}$$

Position demand value × Electronic gear ratio = Position demand internal value

**— Precautions —**

1 The electronic gear ratio is only valid within the range of 1/1000× to 128000×.

Exceeding this range results in the value being saturated within the range, and Err88.3.0 “Improper operation error protection” is triggered.

2 If the unsigned 64-bit size is exceeded during the calculation of the electronic gear ratio, Err88.3.0 “Improper operation error protection” is triggered.

3 If signed 32-bit size is exceeded by the final calculation result for the electronic gear ratio, Err88.3.0 “Improper operation error protection” is triggered.

4 The absolute encoder position [pulse]/electronic gear ratio values must be within the range of $-2^{31}$ (-2147483648) to $+2^{31}$-1(2147483647) in the positional information initialization processing when going from Init -> PreOP in absolute mode.

If this range is exceeded, Err29.1.0 “Counter overflow protection 1” is triggered.

Check the operational range for the absolute encoder position and the electronic gear ratio.

5 The electronic gear ratio is set using multiple objects.

Error incidence may increase depending on the combination of settings.

6 This is also set automatically depending on the encoder resolution when using Obj.608Fh:01h “Encoder increments” . This is also set automatically depending on the encoder resolution when using full-closed controls.

Also, the shipping value of Obj.6092h:01h “Feed” is set so that $2^{23}$ [command unit] is one motor revolution.

When using a mode other than semi-closed control, pay attention to the electronic gear ratio setting.

7 The electronic gear ratio is set at the times indicated below.

Note that even if the set values for related objects are changed, they are not reflected as-is.

- When control power is turned on
- When communication is established (when ESM state transitions from Init → PreOP)

- When homing operation is completed
- When clearing of multi-turn data via the Set-up Support Software (PANATERM ver.7) and EtherCAT
- When operation (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) is completed with Set-up Support Software (PANATERM ver.7)
- When Config is executed by Set-up Support Software (PANATERM ver.7)
- When Err27.4.0 “Position command error protection” occurs

8 The encoder resolution of the A7 Series has been increased to 27 bits from the previous series. When using the A7 Series with a small electronic gear ratio, such as the default setting of 1x electronic gear ratio, the following points should be noted.

- The 32-bit position information [command unit], such as command position and actual position, wraps around in at most 32 motor revolutions. Since the home information is lost at that point, if this electronic gear ratio causes a problem, consider performing position control on the host device side or increasing the electronic gear ratio.
- Since, for example, 32 bits will overflow at approximately 960 r/min when the electronic gear ratio is 1x, when 32-bit speed information such as command speed or actual speed is used in [command unit/s] units, consider using a speed range where this does not occur or increasing the electronic gear ratio.

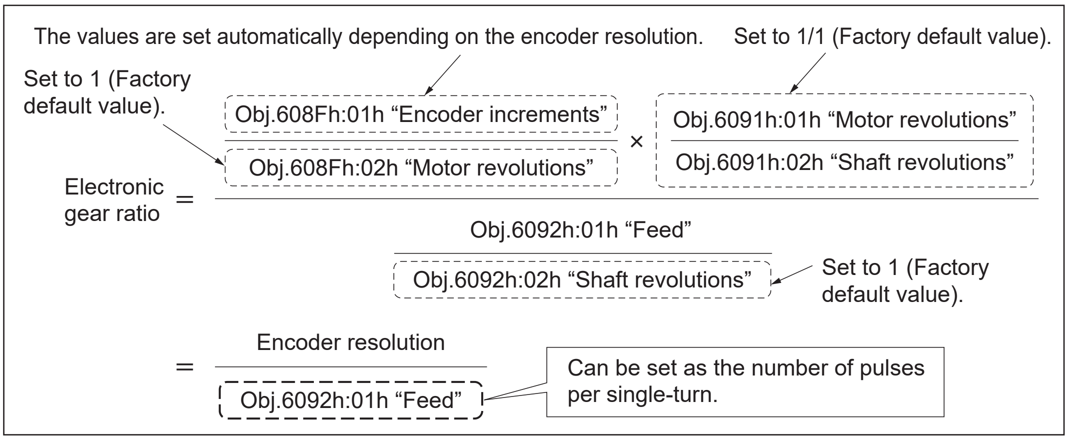
## How to use

- Electronic gear ratio settings

The MINAS A7N Series uses Pr0.08 “Number of command pulses per one motor revolution” and Pr0.09 “Numerator of electronic gear” /Pr0.10 “Denominator of electronic gear” for electronic gear ratio setting, which is not supported by the MINAS A7B Series.

See the following if setting the electronic gear ratio using the number of command pulses per one motor revolution or the numerator/denominator of electronic gear.

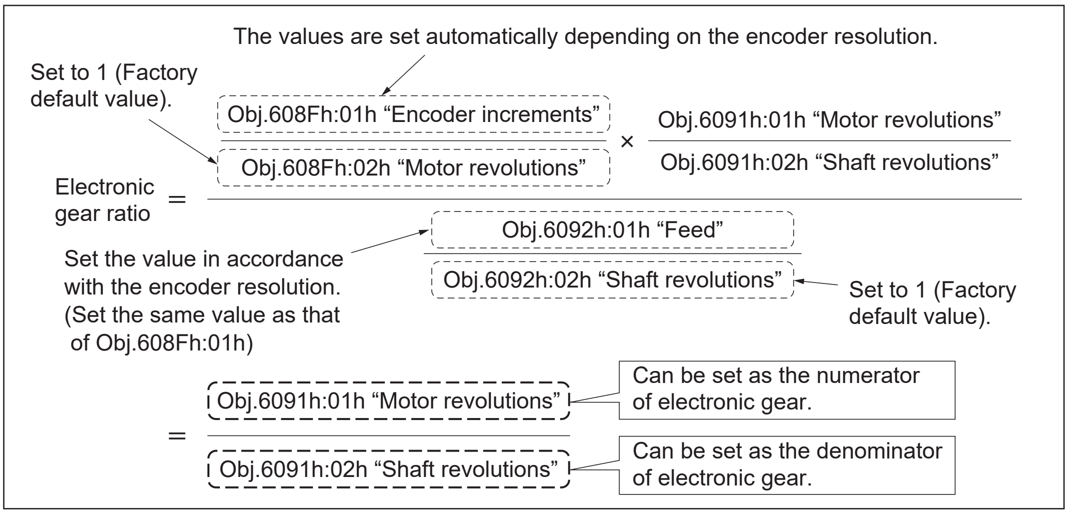
- **If setting the electronic gear ratio by setting the number of command pulses per one motor revolution when using semi-closed control**



Obj.608Fh:01h “Encoder increments” is set automatically from the resolution of the connected encoder.

By setting Obj.608Fh:02h “Motor revolutions” , Obj.6091h:01h “Motor revolutions” , Obj.6091h:02h “Shaft revolutions” , and Obj.6092h:02h “Shaft revolutions” to 1 (factory default value), Obj.6092h:01h “Feed” can be set as the “number of command pulses per one motor revolution”.

- **If setting the electronic gear ratio by setting the numerator/denominator of electronic gear when using semi-closed controls or full-closed controls**



Obj.608Fh:01h “Encoder increments” is set automatically from the resolution of the connected encoder.

By setting Obj.6092h:01h “Feed” to the encoder resolution (same value as Obj.608Fh:01h “Encoder increments” , factory default value for 27-bit/r encoder) and further setting Obj.608Fh:02h “Motor revolutions” and Obj.6092h:02h “Shaft revolutions” to 1 (factory default value), Obj.6091h:01h “Motor revolutions” can be set as the “numerator of electronic gear” and Obj.6091h:02h “Shaft revolutions” as the “denominator of electronic gear”.

● Backing up electronic gear set values

Electronic gear-related objects (Obj.6091h:01h “Motor revolutions” ,Obj.6091h:02h “Shaft revolutions” ,Obj.6092h:01h “Feed” , andObj.6092h:02h “Shaft revolutions” ) are objects to be backed up.

Backing up (writing to EEPROM) is recommended after making any changes.

Backing up means that there is no need to change settings each time you activate the control power.

For backup methods, see *“6.3.5 Store Parameters (Write Object to EEPROM) (1010h)”* .

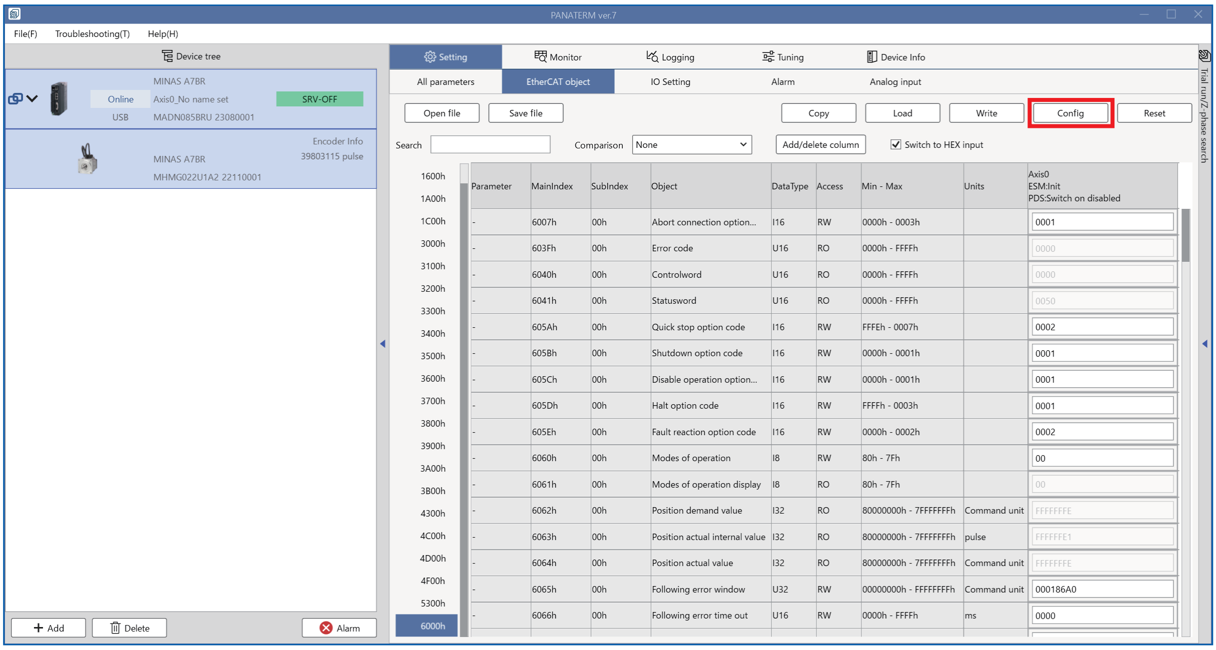
● Setting electronic gears and creating back-ups using the object editor

Objects can be set and backed up using the Set-up Support Software (PANATERM ver.7) object editor. When Set-up Support Software (PANATERM ver.7) is connected via EoE communication, it is not possible to write objects in the object editor.

Electronic gear settings changed in the object editor are immediately reflected in the actual object. Note, however, that the electronic gear ratio setting using the object is reflected according to the following timing.

- When control power is turned on
- When communication is established (when ESM state transitions from Init → PreOP)
- When homing operation is completed
- When clearing of multi-turn data via the Set-up Support Software (PANATERM ver.7) and EtherCAT
- When operation nn(trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) is completed with Set-up Support Software (PANATERM ver.7)

- When Config is executed by Set-up Support Software (PANATERM ver.7) (see figure below)



| Parameter | MainIndex | SubIndex | Object | DataType | Access | Min - Max | Units | Axis0<br>ESM:Init<br>PDS:Switch on disabled |
|---|---|---|---|---|---|---|---|---|
| - | 6007h | 00h | Abort connection option... | I16 | RW | 0000h - 0003h | | 0001 |
| - | 603Fh | 00h | Error code | U16 | RO | 0000h - FFFFh | | 0000 |
| - | 6040h | 00h | Controlword | U16 | RO | 0000h - FFFFh | | 0000 |
| - | 6041h | 00h | Statusword | U16 | RO | 0000h - FFFFh | | 0050 |
| - | 605Ah | 00h | Quick stop option code | I16 | RW | FFFEh - 0007h | | 0002 |
| - | 605Bh | 00h | Shutdown option code | I16 | RW | 0000h - 0001h | | 0001 |
| - | 605Ch | 00h | Disable operation option... | I16 | RW | 0000h - 0001h | | 0001 |
| - | 605Dh | 00h | Halt option code | I16 | RW | FFFFh - 0003h | | 0001 |
| - | 605Eh | 00h | Fault reaction option code | I16 | RW | 0000h - 0002h | | 0002 |
| - | 6060h | 00h | Modes of operation | I8 | RW | 80h - 7Fh | | 00 |
| - | 6061h | 00h | Modes of operation display | I8 | RO | 80h - 7Fh | | 00 |
| - | 6062h | 00h | Position demand value | I32 | RO | 80000000h - 7FFFFFFFh | Command unit | FFFFFFFE |
| - | 6063h | 00h | Position actual internal value | I32 | RO | 80000000h - 7FFFFFFFh | pulse | FFFFFFE1 |
| - | 6064h | 00h | Position actual value | I32 | RO | 80000000h - 7FFFFFFFh | Command unit | FFFFFFFE |
| - | 6065h | 00h | Following error window | U32 | RW | 00000000h - FFFFFFFFh | Command unit | 000186A0 |
| - | 6066h | 00h | Following error time out | U16 | RW | 0000h - FFFFh | ms | 0000 |

## 7.2.4 Motor Working Range Setup Function

This function triggers an alarm and decelerates the motor to a stop if the motor position exceeds the motor operation working range with respect to the position command input range.

The motor operation working range is calculated inside the product according to the following formula.

- Positive direction motor operation working range = positive direction position command input range + Pr5.14 “Motor working range setup”
- Negative direction allowable motor operation working range = negative direction position command input range - Pr5.14 “Motor working range setup”

If the actual motor position for judgment exceeds this range, Err34.0.0 “Motor movable range setup error protection” is triggered.

Note that this function does not protect against erroneous position commands.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control and full-closed control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor rotates normally. |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 14 | A | Motor working range setup | 0 to 1000 | 0.1 rotation | Sets the motor operation working range for the position command input range.<br>If this setup value is exceeded, Err34.0.0 “Motor movable range setup error protection” is triggered.<br>The protection function is disabled when this setup value is 0.<br>Also, the protection function is disabled even if detection of *“Operation”* “Err34.0.0 “Motor movable range setup error protection” ” is disabled. |
| 6 | 97 | B | Function expansion setup 3 | -2147483648 to 2147483647 | — | Set the functions in bit units.<br>bit 2: Motor movable range error protection expansion<br>0: Disabled<br>1: Enabled |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Operation

- Motor operation working range

  The motor operation working range is the movement amount range set by Pr5.14 “Motor working range setup” on both sides of the motor position. Inputting the position command expands the range by exactly the position command amount.

  Err34.0.0 “Motor movable range setup error protection” occurs when the actual motor position for judgment enters the error occurrence range (area shaded with light slanted lines in the operation example in the figure below) due to oscillation, etc.

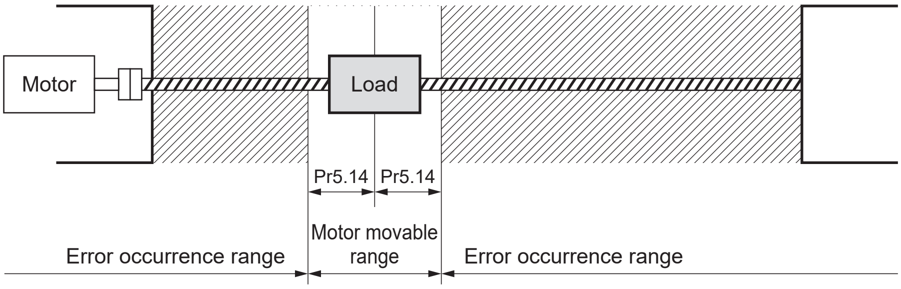
When the motor working range setup protection activates, the motor decelerates and stops according to Pr5.10 “Sequence at alarm” .

Since, depending on the load, loads may hit and damage the machine end during this deceleration, set the Pr5.14 “Motor working range setup” setting range so that it allows for the deceleration operation.

Operation examples are shown below.

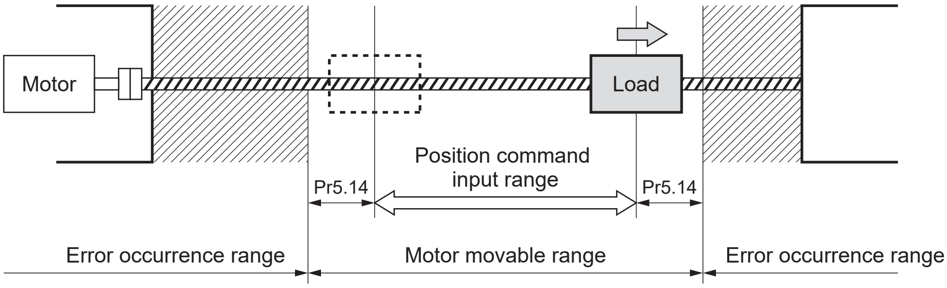
- **When position command is not input (servo-on state)**

  As no position command is entered, the motor operation working range serves as the range of movement set in Pr5.14 “Motor working range setup” on both sides of the load position.



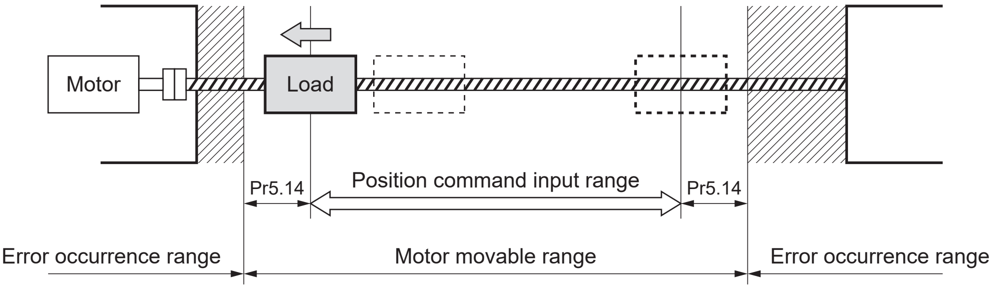
- **During right side operation (servo-on state)**

  When a position command is input to the right, the motor operation working range expands by exactly the position command amount and becomes the number of rotations range set in Pr5.14 “Motor working range setup” on both sides of the position command input range.



- **During left side operation (servo-on state)**

  When a position command is input to the left, the position command input range expands further.



- When the Err34.0.0 “Motor movable range setup error protection” detection process is disabled
  - When any of the following values ([encoder pulse] or [external scale pulse] units) managed internally in this product exceed the range of $-2^{63}$ to $2^{63}-1$, detection of Err34.0.0 “Motor movable range setup error protection” is disabled.
    - Position command input range
    - Actual motor position for judgment
    - Motor movable range

To enable the Err34.0.0 “Motor movable range setup error protection” detection process, set Pr6.97 “Function expansion setup 3” :bit 2 “Motor movable range error protection expansion” to 1 (enable).

- If any of the following conditions are met, the position command input range and actual motor position for judgment managed inside this product are cleared, and the Err34.0.0 “Motor movable range setup error protection” detection process is disabled.
  - When control power is turned on
  - Servo-off state
  - Velocity control state or torque control state
  - Performing frequency characteristics analysis with Set-up Support Software (PANATERM ver.7)
  - When position deviation is cleared (during transition of ESM state from Init -> PreOP, when clearing the position deviation during deceleration to stop operations resulting from alarms, etc.)
  - At position information initialization

    During absolute clear by Set-up Support Software (PANATERM ver.7) , etc.
  - Pr5.14 “Motor working range setup” = 0
  - When position deviation is cleared during deceleration to stop due to over-travel inhibit input
  - During homing
  - If Pr5.14 “Motor working range setup” satisfies the formula below during full-closed control (When the value obtained by converting Pr5.14 to the [External scale pulse] unit exceeds $2^{63}$-1)

    Pr5.14 > (($2^{63}$ -1) × Pr3.24 × 10)/(Encoder resolution × Pr3.25)
- To enable the Err34.0.0 “Motor movable range setup error protection” detection process, set Pr6.97 “Function expansion setup 3” :bit 2 “Motor movable range error protection expansion” to 1 (enable).

### ■ Precautions

When changing the control mode (including for the purpose of only velocity control or torque control), do not use this function. Instead, use the software limit function or over-travel inhibit input.

## 7.2.5 Two-degree-of-freedom Control Mode

The two-degree-of-freedom control mode is an expansion function for each control mode that improves responsiveness by setting command response and servo stiffness independently.

There are two types of two-degree-of-freedom control modes as shown below.

- Standard type: Control mode suitable for positioning control
- Synchronization type: Control mode used when controlling multiple loci such as with multijoint robots, etc.

Type to be used varies with control mode. See *"Setup value"* .

### ■ Operational conditions

- Conditions for enabling two-degree-of-freedom control

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, and full-closed control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor rotates normally. |

The types of two-degree-of-freedom control real-time auto tuning used with each mode are described in the table below.

○: Can be used ×: Cannot be used

| Real-time auto tuning type | Position control | Velocity control | Full-closed control |
|---|---|---|---|
| Standard type | ○ | ○ | ○ |
| Synchronization type | ○ | × | × |

If a type that cannot be used is set, Err88.1.0 "Control mode setting error protection" is triggered.

Although two-degree-of-freedom control mode is not supported during torque control, when the settings are Pr6.47 "Function expansion setup 2" :bit 0 "two-degree-of-freedom control mode" = 1 (enabled), Err88.1.☐ "Control mode setting error protection" will not be triggered.

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 2 | 45 | B | Function expansion setup 10 | -32768 to 32767 | — | Sets whether to permit or prohibit various functions.<br>bit 1 to 0: Two-degree-of-freedom control function setting<br>00b: Two-degree-of-freedom control (MINAS A6 Series specification)<br>01b: Two-degree-of-freedom control (MINAS A7 Series specification)<br>10b: Manufacturer use<br>11b: Manufacturer use |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Set the functions in bit units.<br>bit 0: Two-degree-of-freedom control mode<br>0: Disabled<br>1: Enabled<br>bit 3: Two-degree-of-freedom control real-time auto tuning selection<br>0: Standard type<br>1: Synchronization type<br>**Notes**<br>● bit 3 can only be used when bit 0 is 1. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

The parameters that can be set when two-degree-of-freedom control mode is enabled in each mode are as follows.

For details on setting values, see *“7.3 Position Control”* , *“7.4 Velocity Control”* , and *“7.6 Full-closed Control”* .

○: Setting enabled ×: Setting disabled

| Class | No. | Parameter name | Position control | Velocity control | Full-closed control |
|---|---|---|---|---|---|
| 2 | 22 | Positional command smoothing filter | ○ | ○ | ○ |
| 2 | 38 | Filter function switching | ○ | ○ | ○ |
| 2 | 39 | Custom notch compensation coefficient | ○ | ○ | ○ |
| 2 | 40 | Custom notch compensation frequency 1 | ○ | ○ | ○ |
| 2 | 41 | Custom notch compensation frequency 2 | ○ | ○ | ○ |
| 2 | 42 | Custom notch frequency | ○ | ○ | ○ |
| 2 | 43 | Custom notch width | ○ | ○ | ○ |
| 2 | 44 | Custom notch depth | ○ | ○ | ○ |
| 2 | 46 | Tuning filter 2 | ○ | ○ | ○ |
| 6 | 48 | Tuning filter | ○ | ○ | ○ |
| 6 | 49 | Command response/tuning filter attenuation term | ○ | × | ○ |
| 6 | 50 | Viscous friction compensating gain | ○ | × | ○ |

## ■ How to use

- When two-degree-of-freedom control mode is enabled

  Set Pr6.47 “Function expansion setup 2” :bit 0 to 1, and then, after writing it to EEPROM, enable two-degree-of-freedom control mode by resetting the control power supply.

  Next, use the real-time auto tuning function (two-degree-of-freedom control mode standard type or two-degree-of-freedom control mode synchronization type) to adjust the basic gain settings and load fluctuation compensation.

  If further improvement is required, manually make fine adjustments to the parameters shown in the *“Setup value”* while checking the response.

- When the two-degree-of-freedom control mode is disabled

  Set Pr6.47 “Function expansion setup 2” :bit 0 to 0, and then, after writing it to EEPROM, disable two-degree-of-freedom control by resetting the control power supply.

  Next, using the real-time auto tuning function, set basic gain and adjust load fluctuation compensation.

## 7.2.6 Regenerative Resistor Settings

A function to setup the regenerative resistor overload protection function.

For details on the regenerative resistor specifications, see *"12.4.12 External Regenerative Resistor"* .

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Setup value

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 16 | C | External regenerative resistor setup | 0 to 3 | — | Sets this parameter according to whether the regenerative resistor built into this product is to be used as-is, or the built-in resistor is to be disconnected and an external regenerative resistor is to be provided.<br>0: Use the built-in resistor, and perform regenerative overload protection.<br>1: Use an external resistor, and perform regenerative overload protection.<br>2: Use an external resistor, but do not perform regenerative overload protection.<br>3: Use without a regenerative resistor (Regenerative overload protection not performed). |
| 0 | 17 | C | Selection of load factor for external regenerative resistor | 0 to 4 | — | Sets the method for computing regenerative resistance load factor an external regenerative resistor is selected (Pr0.16 = 1 or 2).<br>0: Regenerative load factor is 100% when duty factor of external regenerative resistor is 10%.<br>1 to 4: Manufacturer use (setting is prohibited) |

*1 For attributes, see *"6.2 Object Dictionary List"* .

### 7.2.7 Absolute Encoder

The absolute encoder is an encoder that can back up motor position information when the power supply is off.

With an absolute encoder, it is possible to create an absolute system that does not require a homing operation after the power supply is turned on by setting Pr0.15 "Absolute encoder setup" to something other than "1" (default setting).

With full-closed control, an external scale can be used to create an absolute system that does not require a homing operation after the power supply is turned on.

#### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | • Position control, velocity control, torque control |

#### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 15 | C | Absolute encoder setup | 0 to 4 | — | Sets the method of use of the absolute encoder.<br>During full-closed control, the absolute encoder is treated as an incremental system (setting = 1) by the internal control.<br>• 0: Use as an absolute system (absolute mode).<br>• 1: Use as an incremental system (incremental mode) (Detection of the following protection functions is disabled.).<br>Err40.0.0 "Absolute system down error protection"<br>Err41.0.0 "Absolute counter over error protection"<br>Err42.0.0 "Absolute overspeed error protection"<br>Err45.0.0 "Multi-turn counter error protection"<br>• 2: Use as an absolute system (absolute mode), but ignore multi-turn counter overs.<br>• 3: Use as an absolute system (absolute mode), but do not use the multi-turn counter (Single-turn absolute encoder mode. For details, see *"8.4 Single-turn Absolute Function"* .).<br>• 4: Use as absolute system (absolute mode), but any value can be set for the upper-limit value of the multi-turn counter. Ignore multi-turn counter overs (Continuous rotating absolute encoder mode. For details, see *"8.5 Continuous Rotating Absolute Encoder Function"* .).<br>**Notes**<br>• Set to 0 if using the full-closed control function (rotary scale). |

*1 For attributes, see *"6.2 Object Dictionary List"* .

#### ■ How to use

- Regarding the necessity of connecting the battery to the absolute encoder

  The following two types of data are read from the absolute encoder (27 bit/r).

  - Single-turn data that indicates position within one motor rotation
  - Multi-turn data counted once per single turn

Both data are combined into absolute data, which provides information on the current position of the motor.

Both types of data have polarities that increase with CCW rotation.

The following two types of absolute encoders exist, which differ depending on the method in which multi-turn data is backed up.

- Absolute encoder (battery backup)
  A type that requires a battery connection to back up multi-turn data
- Batteryless absolute encoder
  A type that does not require a battery connection to back up multi-turn data

The table below shows the relationships between the absolute encoder types and Pr0.15 “Absolute encoder setup” .

| Absolute encoder type | Pr0.15 “Absolute encoder setup” | |
|---|---|---|
| | 0, 2, 4 | 1, 3 |
| Battery backup | Battery required | Battery not required |
| Batteryless | Battery not required | |

For details on how to install batteries connected to the absolute encoder (battery backup), see *“2.4.2 Battery for Absolute Encoder”* .

● Absolute encoder clearing operation

When operating the machine for the first time, multi-turn data must be cleared to 0 by clearing the absolute encoder at the home position. This clearing operation is called "multi-turn data clear".

Multi-turn data is cleared with Set-up Support Software (PANATERM ver.7) or EtherCAT communication.

When clearing multi-turn data, turn off the control power supply once, and then turn it back on.

For the method of clearing the absolute encoder, see Set-up Support Software (PANATERM ver.7) Operating Manual or *“6.6.8.4.4 Initialization of Absolute Encoder (During Semi-closed Control)”* .

● Battery refresh operation of the absolute encoder (battery backup)

If the absolute encoder battery (lithium-thionyl chloride battery) continues to be in a non-discharged state, including during long-term storage, a battery alarm, due to a temporary drop in voltage, may occur at the next discharge.

To avoid triggering a battery alarm, perform a battery refresh with Set-up Support Software (PANATERM ver.7) . For details on refreshing the battery, see *“2.4.2.3 Battery Refresh (Method Using Set-up Support Software (PANATERM ver.7) )”* .

**— Precautions —**

● Executing a battery refresh may result in a battery warning.
  If a battery warning is generated, clear the battery warning.

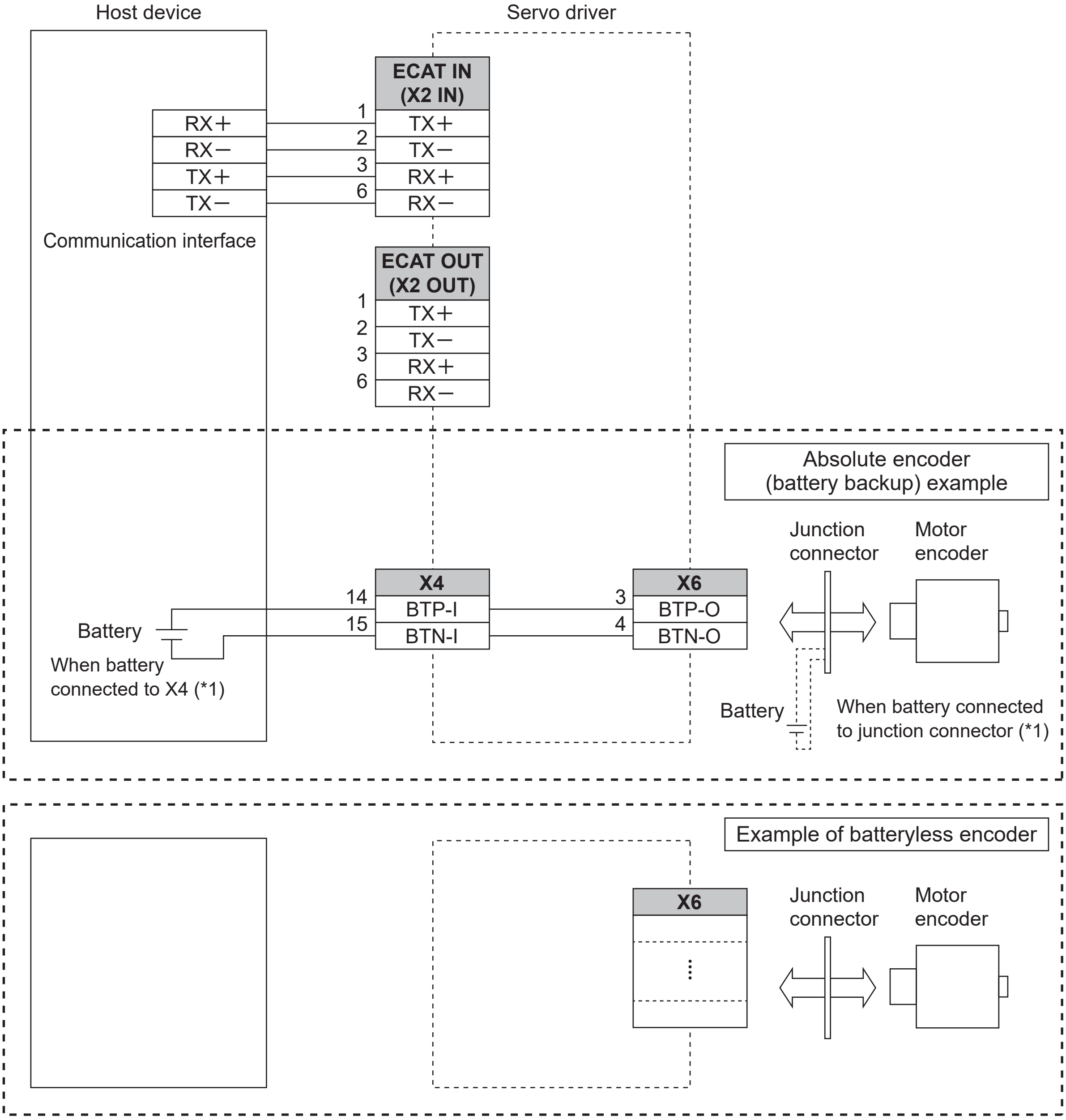
● Do not perform a battery refresh with batteryless absolute encoders.

## ■ Control block diagram

- Absolute system configuration with absolute encoder

Absolute data is transmitted to the host device as the current position in the EtherCAT communication response (servo driver -> host device).

### Example of when the servo driver is connected to one axis



*1 When connecting the battery, connect it to either connector X4 or the junction connector between connector X6 and the encoder. Under no circumstances should both be connected at the same time.

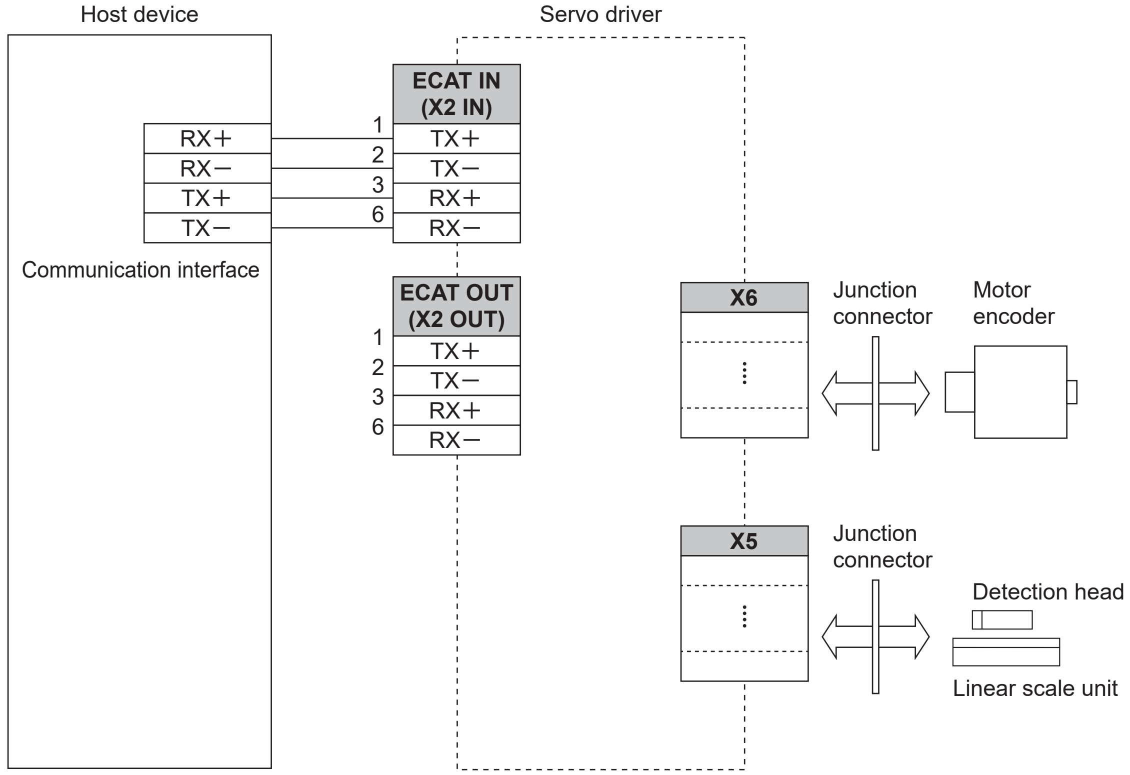
**— Precautions —**

- When replacing the battery, be sure to turn on the control power supply. If the control power supply is not applied, retained absolute data will be lost.

- Absolute system configuration with external scale (full-closed control)

  Absolute data is transmitted to the host device as the current position in the EtherCAT communication response (servo driver -> host device).

### Example of when the servo driver is connected to one axis (when using external scale)



## 7.2.8 External Scale Selection Function

This function selects the type of external scale to be used and sets the direction reversal of the external scale feedback counter.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |
| Other | ● Driver type must be one other than standard type. |

### ■ Setup value

—: None

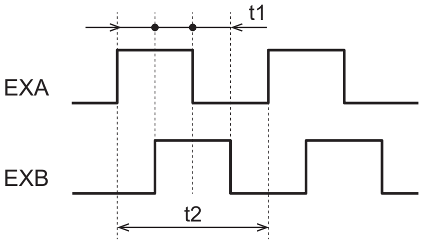
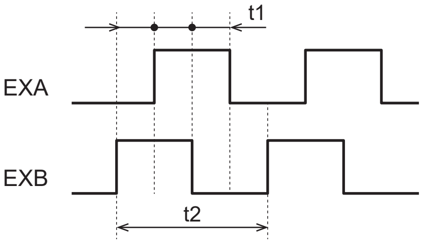
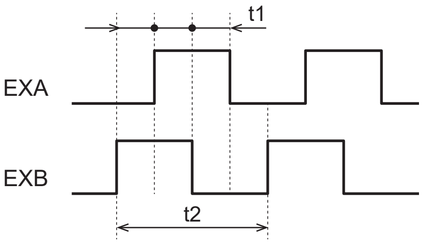
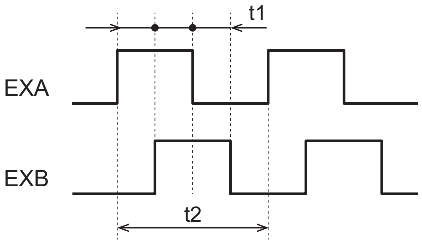
<table>
<tr><th>Class</th><th>No.</th><th>Attribute (*1)</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>3</td><td>23</td><td>R</td><td>External scale selection</td><td>0 to 2</td><td>—</td><td>Select the type of external scale.</td></tr>
<tr><td colspan="7">0: A/B-phase output type<br>1: Serial communication type (incremental)<br>2: Serial communication type (absolute)<br>● Please ensure the settings correspond to the type of external scale used. The table below shows the relationship between the external scale and the setting values.
<table>
<tr><th rowspan="2">External scale type used</th><th colspan="3">Setup value of Pr3.23</th></tr>
<tr><th>0</th><th>1</th><th>2</th></tr>
<tr><td>A/B-phase output type</td><td>Enabled</td><td>Err50.0.0 “External scale wiring error protection” is triggered</td><td>Err50.0.0 “External scale wiring error protection” is triggered</td></tr>
<tr><td>Serial communication type (incremental)</td><td rowspan="2">Err55.0.0 “A-phase connection error protection” , Err55.1.0 “B-phase connection error protection” , Err55.2.0 “Z-phase connection error protection” are triggered</td><td>Enabled</td><td>Err93.3.2 “External scale connection error protection” is triggered</td></tr>
<tr><td>Serial communication type (absolute)</td><td>Err93.3.1 “External scale connection error protection” is triggered</td><td>Enabled</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>26</td><td>R</td><td>Reversal of direction of external scale</td><td>0 to 3</td><td>—</td><td>Set the reversal of external scale feedback counter.<br>0: Not reversed<br>1: Reversed<br>2: Manufacturer use (setting is prohibited)<br>3: Manufacturer use (setting is prohibited)</td></tr>
</table>

*1 For attributes, see *“6.2 Object Dictionary List”* .

Pr3.23 external scale type details

| Pr3.23 | External scale type | Supported speeds (*3) |
|---|---|---|
| 0 | A/B-phase output type (*1) (*2) (*4) | Up to 4 Mpulse/s (after being multiplied by 4) |
| 1 | Serial communication type (incremental) (*2) (*4) | Up to 4 Gpulse/s |
| 2 | Serial communication type (absolute) (*2) (*4) | Up to 4 Gpulse/s |

*1 The following table shows internal process counting direction of this product for A/B-phase output type external scales.

| Pr3.26 “Reversal of direction of external scale” | Count-down direction | Count-up direction |
|---|---|---|
| 0: Not reversed |  <br>EXB is 90° behind EXA<br>t1 > 0.25 µs<br>t2 > 1.0 µs |  <br>EXB is 90° ahead of EXA<br>t1 > 0.25 µs<br>t2 > 1.0 µs |
| 1: Reversed |  <br>EXB is 90° ahead of EXA<br>t1 > 0.25 µs<br>t2 > 1.0 µs |  <br>EXB is 90° behind EXA<br>t1 > 0.25 µs<br>t2 > 1.0 µs |

*2 Connect the external scale so that when the motor axis turns CCW, the scale counting direction counts up, and when the motor axis turns CW it counts down. If this connection arrangement is impossible due to installation conditions, etc., the scale counting direction can be reversed with Pr3.26 “Reversal of direction of external scale” .

**Notes**

- The following procedure can be used to confirm installation direction.

1 Check the following items with Set-up Support Software (PANATERM ver.7) .

1-1 Count direction for external scale feedback pulse sum

1-2 Count direction for encoder feedback pulse sum

2 Compare the counting direction in “1-1” and “1-2”.

If they match, connection is normal.

If they do not match, they did not connect normally. Set Pr3.26 “Reversal of direction of external scale” to the opposite value (0 -> 1 or 1 -> 0).

*3 Supported speeds refer to the external scale feedback speeds [pulse/s] that can be processed by this product.

See the external scale specifications for the working ranges that can be supported by the scales.

The speed of the external scale is limited to 4 m/s when an external scale with 1 nm resolution is used in serial communication type.

However, caution is required because, even with full-closed control, overspeed protection occurs when motor axis rotational speed exceeds maximum velocity.

*4 Please contact us for information on compatible external scales.

### 7.2.9 Pre-gain Adjustment Protection Function Setup

When running the motor, it can be used with greater peace of mind by making the following settings appropriately according to device usage conditions.

- Over-travel inhibit input setup

  Inputting the limit sensor signal to this product can help prevent collisions with the mechanical end. Use positive direction over-travel inhibit input (POT) and negative direction over-travel inhibit input (NOT), which are both external input signals. The following over-travel inhibit input-related parameters must also be set.

  Pr5.04 “Over-travel inhibit input setup”
  Pr5.05 “Sequence at over-travel inhibit”

  Since limit input is normally controlled by the host device, set over-travel inhibit input to disabled in this product. Be sure to check the host device specifications.

  For details, see *“8.12 Deceleration to Stop Function for During Over-travel Inhibit Input (POT, NOT)”* .

- Torque limit setup

  Limiting motor maximum torque can minimize damage caused by disturbances such as machine jamming and collisions. When setting a uniform limit using Pr0.13 “1st torque limit” , set Pr5.21 “Selection of torque limit” to 0 or 1 before setting the value.

  However, caution is required because, if torque is limited to below the actual required torque, overspeed protection caused by overshoot and position deviation excess protection may occur due to delayed command response.

  Torque limit conditions can be detected externally by allocating the external output signal torque limitation output (TLC) to the output signal.

  For details, see *“8.1 Torque Limit Switching Function”* .

- Overspeed protection setup

  Generates Err26.0.0 “Overspeed protection” when motor speed is abnormally high.

  The factory default setting is set to the overspeed level in the applicable motor.

  If your application requires speeds below the motor maximum speed, set Pr5.13 “Over-speed level setup” using the formula below.

  Pr5.13 “Over-speed level setup” = Vmax × (1.2 to 1.5)
  Vmax: Motor maximum speed [r/min] under operating conditions
  Range in ( ) is the margin to prevent frequent activation of overspeed protection.

  When running the motor at a low speed during the initial adjustment stage, set up the overspeed protection by multiplying the adjusting speed by a certain margin to protect the motor against potential oscillation.

  For details, see *“7.5.2 Velocity Limit Function”* and *“8.16 Emergency Stop Function for When Alarm is Triggered”* .

- Motor working range setup

  Err34.0.0 “Motor movable range setup error protection” is generated when the actual motor position for judgment exceeds the motor operation working range during position control or full-closed control.

  The motor operation range is calculated inside the product according to the following formula.

  - Positive direction motor operation working range = positive direction position command input range + Pr5.14 “Motor working range setup”
  - Negative direction allowable motor operation working range = negative direction position command input range - Pr5.14 “Motor working range setup”

  For details, see *“7.2.4 Motor Working Range Setup Function”* .

- Hybrid deviation excess protection setup

  When performing initial operation with full-closed control, abnormal operation may occur due to reverse connection of the external scale or incorrect setting of the external scale dividing ratio.

To indicate this type of defect, Err25.0.0 “Hybrid deviation excess protection” is triggered when the deviation of the motor position (encoder unit) and load position (external scale unit) exceed Pr3.28 “Hybrid deviation excess setup” .

For details, see *“7.6.5 Hybrid Deviation Excess Setup”* .

- Position deviation excess protection setup

During position control or full-closed control, this detects potential excessive differences between the positional command and motor position, and issues Err24.0.0 “Position deviation excess protection” .

Excessive position deviation level can be set at Pr0.14 “Position deviation excess setup” . Detection locations can be selected from the command position deviation [pulse (command unit)] and encoder position deviation [pulse (encoder unit)] using Pr5.20 “Position setup unit select” . For detection locations, see the table below.

| Related | |
|---|---|
| *“7.3.2 Position Control (Two-degree-of-freedom Control Mode Enabled)”* | *“Control block diagram: Position control (when two-degree-of-freedom control mode is enabled) ”* |
| *“7.3.3 Position Control (Two-degree-of-freedom Control Mode Disabled)”* | *“Control block diagram: Position control (when two-degree-of-freedom control mode is disabled)”* |
| *“7.6.2 Full-closed Control (Two-degree-of-freedom Control Mode Enabled)”* | *“Control block diagram: Full-closed control (when two-degree-of-freedom control mode is enabled)”* |
| *“7.6.3 Full-closed Control (Two-degree-of-freedom Control Mode Disabled)”* | *“Control block diagram: Full-closed control (when two-degree-of-freedom control mode is disabled)”* |

Related parameters

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 14 | A | Position deviation excess setup | 0 to $2^{30}$ | Command unit | Sets the position deviation excess setup range. Err24.0.0 “Position deviation excess protection” detection is disabled when the setup value is 0.<br>Units follow Pr5.20 “Position setup unit select” .<br>The factory default value is equivalent to 10 motor revolutions at 23 bits. If the command pulse per single-turn is changed, this setup value will also be affected. Configure settings appropriately according to the safety features of the equipment. |
| 5 | 20 | C | Position setup unit select | 0 to 1 | — | Selects setup units for positioning complete (In-position) range and position deviation excess.<br>0: Command unit<br>1: Encoder unit (external scale unit)<br>**— Precautions —**<br>● The EtherCAT communication positioning complete detection threshold value (Obj.6041h:bit 10 “target reached” ) is always in command units regardless of this setup value. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## Pr0.14 “Position deviation excess setup” setting

Because the position deviation during normal operation depends on the operating speed and gain setting, set the value shown in the following formula in Pr0.14 “Position deviation excess setup” based on your operating conditions.

- When two-degree-of-freedom control is enabled (Pr6.47 bit 0 = 1)

- Pr5.20 “Position setup unit select” = 0 (detected by command position deviation)

  Position deviation [command unit] output setting uses position command deviation (after filter) (Pr7.23 bit 14 = 0)

  Pr0.14 “Position deviation excess setup” = Pmax × (1.2 to 2.0)
  Range in ( ) is the margin to prevent frequent activation of position deviation excess protection.
  Since the position deviation in this case cannot be obtained by the calculation formula, estimate the maximum value Pmax of the command position deviation required for use from the actual machine operation waveform, and set the value including a margin.

- Position deviation [command unit] output setting uses position command deviation (before filter) (Pr7.23 bit 14 = 1)

  Pr0.14 “Position deviation excess setup” = (P1 + P2 + P3 + P4) × (1.2 to 2.0)
  Range in ( ) is the margin to prevent frequent activation of position deviation excess protection.

  Position command smoothing (secondary) accumulated pulse count: P1 = Vc × (Pr2.22 setting value/10000) × 2

  Positional command FIR filter accumulated pulse count: P2 = Vc × (Pr2.23 setting value/10000)/2

  Tuning filter accumulated pulse count: P3 = Vc × (Pr6.48 setting value/10000)

  Damping filter accumulated pulse count: P4 = Vc/(π × damping frequency [Hz])

  - Vc: Position command pulse maximum frequency [pulse (command unit)/s]
  - Only calculate damping frequency when the setting value is enabled at a value that is 1/10 the setting value of Pr2.14 “1st damping frequency” , Pr2.16 “2nd damping frequency” , Pr2.18 “3rd damping frequency” , and Pr2.20 “4th damping frequency” . When multiple damping controls are enabled, calculate P4 for each damping filter, and apply the total value to P4.

- When Pr5.20 “Position setup unit select” = 1 (detected by encoder position deviation and full-closed position deviation)

  Pr0.14 “Position deviation excess setup” = Pmax × (1.2 to 2.0)
  Range in ( ) is the margin to prevent frequent activation of position deviation excess protection.
  Since the position deviation in this case cannot be obtained by the calculation formula, estimate the maximum value Pmax of the encoder position deviation or full-closed position deviation required for use from the actual machine operation waveform, and set the value including a margin.

  - Measure with the smallest value when switching position loop gain Kp.
  - When Pr5.20 “Position setup unit select” = 1, command filter and damping control settings have no effect.

● When two-degree-of-freedom control is disabled (Pr6.47 bit 0 = 0)

- Pr5.20 “Position setup unit select” = 0 (detected by command position deviation)

  Position deviation [command unit] output setting uses position command deviation (after filter) (Pr7.23 bit 14 = 0)

  Pr0.14 “Position deviation excess setup” = P1 × (1.2 to 2.0)
  Range in ( ) is the margin to prevent frequent activation of position deviation excess protection.

  Command position deviation: P1 = Vc/Kp × ((100-(Pr1.10 setting value/10))/100)

  - Vc: Position command pulse maximum frequency [pulse (command unit)/s]
  - Kp: Position loop gain [1 $s^{-1}$] (when switching, calculate with the smallest value)

  Position deviation [command unit] output setting uses position command deviation (before filter) (Pr7.23 bit 14 = 1)

  Pr0.14 “Position deviation excess setup” = (P1 + P2 + P3 + P4) × (1.2 to 2.0)
  Range in ( ) is the margin to prevent frequent activation of position deviation excess protection.

  Command position deviation: P1 = Vc/Kp × ((100-(Pr1.10 setting value/10))/100)

Position command smoothing (primary) accumulated pulse count: P2 = Vc × (Pr2.22 setting value/10000)

Positional command FIR filter accumulated pulse count: P3 = Vc × (Pr2.23 setting value/10000)/2

Damping filter accumulated pulse count: P4 = Vc/(π × damping frequency [Hz])

- Vc: Position command pulse maximum frequency [pulse (command unit)/s]
- Kp: Position loop gain [1 $s^{-1}$] (when switching, calculate with the smallest value)
- Only calculate damping frequency when the setting value is enabled at a value that is 1/10 the setting value of Pr2.14 “1st damping frequency” , Pr2.16 “2nd damping frequency” , Pr2.18 “3rd damping frequency” , and Pr2.20 “4th damping frequency” . When multiple damping controls are enabled, calculate P4 for each damping filter, and apply the total value to P4.

- When Pr5.20 “Position setup unit select” = 1 (detected by encoder position deviation and full-closed position deviation)

Pr0.14 “Position deviation excess setup” = P1 × (1.2 to 2.0)
Range in ( ) is the margin to prevent frequent activation of position deviation excess protection.

Encoder position deviation and full-closed position deviation: P1 = Ve/Kp × ((100-(Pr1.10 setting value/10))/100)

- Ve: Maximum operating frequency [pulse/s] in encoder units or full-closed units
- Kp: Position loop gain [1 $s^{-1}$] (when switching, calculate with the smallest value)
- When Pr5.20 “Position setup unit select” = 1, command filter and damping control settings have no effect.
- Note that when switching from velocity control to position control, processing to correct position deviation is used, so the above calculated value and error may increase. To cope with these problems, increase the margin.

**— Precautions —**

● If Pr0.14 “Position deviation excess setup” = 1073741824 or higher and Pr5.20 “Position setup unit select” = 1 in full-closed control, Err29.2.☐ “Counter overflow protection 2” will trigger without triggering Err24.0.0 “Position deviation excess protection” .

## 7.3 Position Control

### 7.3.1 Position Control Overview

The following types of position control mode are available:

- Profile position control (pp)

  This is a position control mode in which the host device designates the target position, target speed, and acceleration/deceleration, and operates by generating position commands inside the servo driver.

- Cyclic position control (csp)

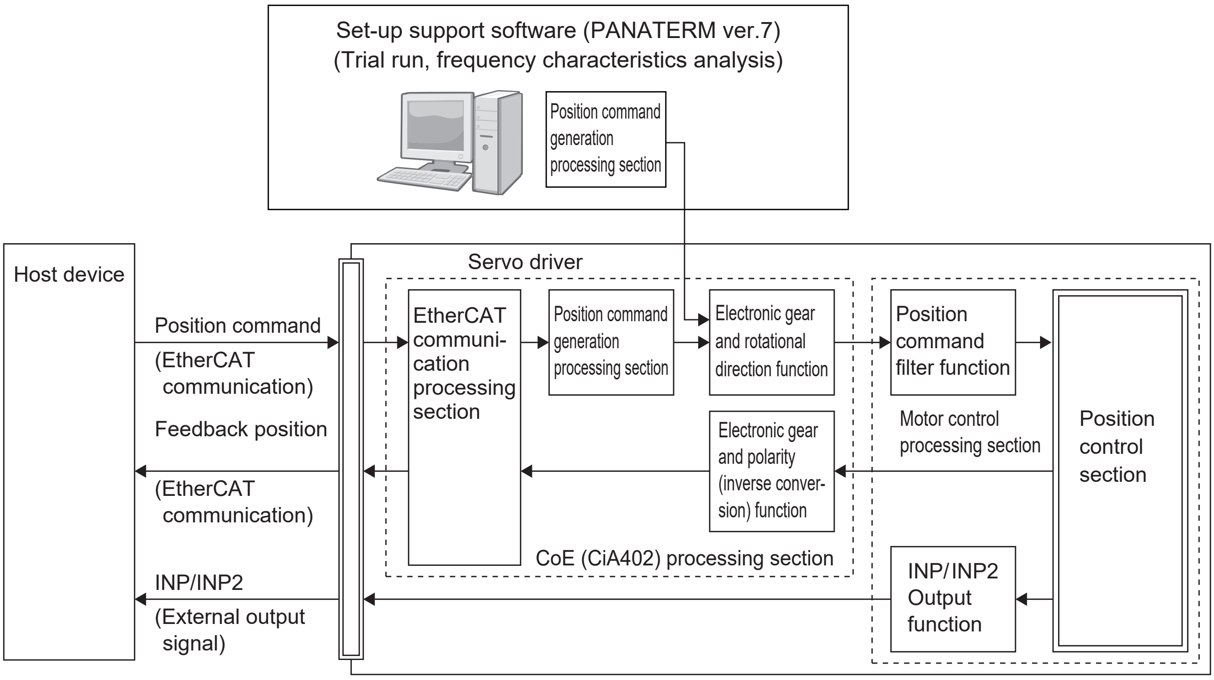
  This is a position control mode in which the host device generates a position command, and operates by updating (sending) a command position in a command updating cycle.

- Homing position control (hm)

  This is a position control mode in which the host device designates the homing method, operating velocity, etc.; generates position commands inside the servo driver; and performs the homing operation.

For details on position control, see *"6.6.5 Position Control Function (pp, csp, ip, hm)"* .

A position control system overview is shown below.



**— Precautions —**

- To prevent sudden motor movement, see Operating Instructions (Tuning).
- The positioning complete state can be checked using positioning complete output (INP) or positioning complete output 2 (INP2), which are external output signals.

  For details, see *“7.3.4 Positioning Complete Output (INP/INP2) Function”* .
- Control mode is forcibly switched inside this product according to its operation status, regardless of commands from the host device. Because this operation also affects input signal assignments, it is generally recommended to assign the same function to each terminal in all modes.

  The conditions for forcibly switching control modes are shown below.

| Operation status if this product | Control mode after forced switching |
|---|---|
| When using Set-up Support Software (PANATERM ver.7) to perform frequency characteristics analysis | ● During position loop characteristics analysis: Position control<br>● During velocity closed-loop characteristics analysis: Velocity control<br>● During torque speed (automatic) analysis: Position control<br>● During torque speed (vertical) analysis: Velocity control<br>● During torque speed (normal) analysis: Torque control |
| During trial run via Set-up Support Software (PANATERM ver.7) | ● Position control |
| Operations with descriptions of “forcible position control” using various deceleration to stop functions ( *“8.12”* to *“8.15”* ) | ● Position control |
| During retracting operations | ● Position control |

## 7.3.2 Position Control (Two-degree-of-freedom Control Mode Enabled)

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control (semi-closed control) |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally. |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Enables and disables two-degree-of-freedom control mode and sets standard or synchronization type. For details, see *“7.2.5 Two-degree-of-freedom Control Mode”* . |
| 2 | 22 | B | Positional command smoothing filter | 0 to 10000 | 0.1 ms | Sets the time constant of the “command response filter” when two-degree-of-freedom control mode is enabled.<br>● Maximum value is limited to 2000 (= 200.0 ms).<br>**Notes**<br>● The parameter value itself is not limited, but the value applied in this product is limited.<br>● Decrease this parameter to speed up the command response, and increase it to slow down the command response.<br>● Attenuation terms are set using Pr6.49 “Command response/tuning filter attenuation term” . |
| 2 | 38 | B | Filter function switching | -32768 to 32767 | — | Enables or disables the filter function.<br>bit 0: Custom notch filter<br>0: Disabled<br>1: Enabled<br>bit 1: Tuning filter 2<br>0: Disabled<br>1: Enabled<br>*Do not switch tuning filter 2 between enabled and disabled during operation. |
| 2 | 39 | B | Custom notch compensation coefficient | 0 to 1000 | 0.01 | Sets the custom notch compensation coefficient. A set value of 100 or less disables compensation. |
| 2 | 40 | B | Custom notch compensation frequency 1 | 0 to 10000 | 0.1 Hz | Sets custom notch compensation frequency 1. A setup value of 0 disables compensation. |
| 2 | 41 | B | Custom notch compensation frequency 2 | 0 to 10000 | 0.1 Hz | Sets custom notch compensation frequency 2. A setup value of 0 disables compensation. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 2 | 42 | B | Custom notch frequency | 10 to 5000 | Hz | Sets the notch frequency of the custom notch filter.<br>A setup value of 5000 disables the custom notch filter. |
| 2 | 43 | B | Custom notch width | 0 to 20 | – | Sets the notch width of the custom notch filter. |
| 2 | 44 | B | Custom notch depth | 0 to 99 | – | Sets the notch depth of the custom notch filter. |
| 2 | 46 | B | Tuning filter 2 | 0 to 20000 | 0.01 ms | Sets the time constant of “Tuning filter 2” during two-degree-of-freedom control.<br>Disabled when the set value is 0 to 3.<br>● Attenuation terms are set using Pr6.49 “Command response/tuning filter attenuation term” . |
| 6 | 48 | B | Tuning filter | 0 to 2000 | 0.1 ms | Sets the time constant of the “tuning filter” in the two-degree-of-freedom control.<br>● When changing the torque filter setup, see the real-time auto tuning setting, and set a value close thereto.<br>● Finely tuning by checking the encoder position deviation of the settling area may improve overshoot or oscillatory waveform.<br>● Attenuation terms are set using Pr6.49 “Command response/tuning filter attenuation term” . |
| 6 | 49 | B | Command response/tuning filter attenuation term | 0 to 99 | – | Sets the “command response filter” and “tuning filter” attenuation terms in the two-degree-of-freedom control.<br>● Sets each filter in decimal notation.<br>Ones: Command response filter<br>Tens: Tuning filter<br><Target digit setting values><br>0 to 4: No attenuation terms (operates as first order lag filter)<br>5 to 9: Attenuation term ζ is 1.0, 0.86, 0.71, 0.50, 0.35, in that order (operates as second order lag filter)<br>＜ Example of this parameter setup ＞<br>To set the command response filter to ζ = 1.0 and the tuning filter to ζ = 0.71, set the setting value to 75 (ones = 5 (ζ = 1.0), tens = 7 (ζ = 0.71)).<br>Note that Pr2.22 “Positional command smoothing filter” is applied to the command response filter time constant. |
| 6 | 50 | B | Viscous friction compensating gain | 0 to 10000 | 0.1 %/ (10000 r/min) | When the two-degree-of-freedom control mode is enabled, the product of the command speed and the setup value is used as the viscous friction torque compensation and the torque command is added to the torque.<br>● Setting the value of the viscous friction coefficient estimation of real-time auto tuning can improve the encoder position deviation of the settling area. |

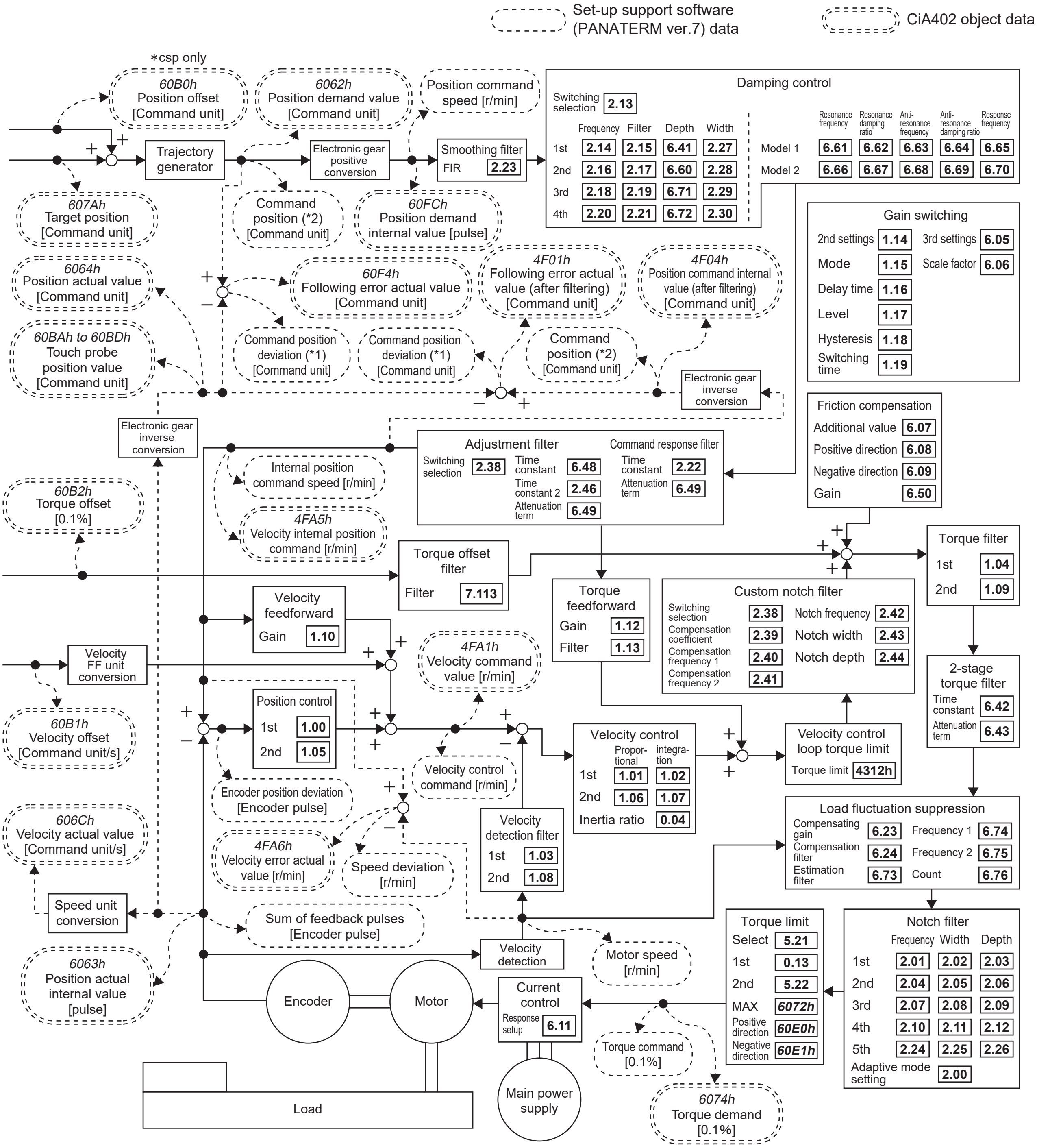
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 7 | 23 | B | Communication function extended setup 2 | -32768 to 32767 | — | bit 14: Position deviation [command unit] output setup<br>0: Internal command position (after filter) [command unit] - actual position [command unit]<br>1: Internal command position (before filter) [command unit] - actual position [command unit] |
| 7 | 99 | B | EtherCAT function expansion setup 6 | -32768 to 32767 | — | bit 3: Command pulse accumulated value [command unit] output setting<br>0: Before filter<br>1: After filter |
| 7 | 113 | B | Torque offset filter | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter for Obj.60B2h:00h “Torque offset” .<br>Disabled when the set value is 0 to 3. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ How to use

For settings to enable two-degree-of-freedom control, see *“How to use”* “Two-degree-of-freedom control” of *“7.2.5 Two-degree-of-freedom Control Mode”* .

## Control block diagram: Position control (when two-degree-of-freedom control mode is enabled)



*1 Methods (criteria) for calculating position deviation on Set-up Support Software (PANATERM ver.7) and on an analog monitor will vary depending on the setting for Pr7.23 “Communication function extended setup 2” :bit 14 “Command position deviation output switching” . For details, see “When switching analog monitor output signal types” in *“3.2.8 Wiring to Connector X7 (Connecting to External Monitor)”* .

*2 Position commands in Set-up Support Software (PANATERM ver.7) depend on Pr7.99 “Communication function extended setup 6” :bit 3 “Command pulse accumulated value [command unit] output setting” settings.

*3 When executing a trial run, Z-phase search, or frequency characteristics (position loop characteristics) from Set-up Support Software (PANATERM ver.7) , the driver switches to position control internally.

* Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.

* Numbers in bold (e.g., **1.00**) represent servo parameter numbers.

* Some objects such as polarity are omitted.

## 7.3.3 Position Control (Two-degree-of-freedom Control Mode Disabled)

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control (semi-closed control) |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally. |

### ■ Setup value

—: None

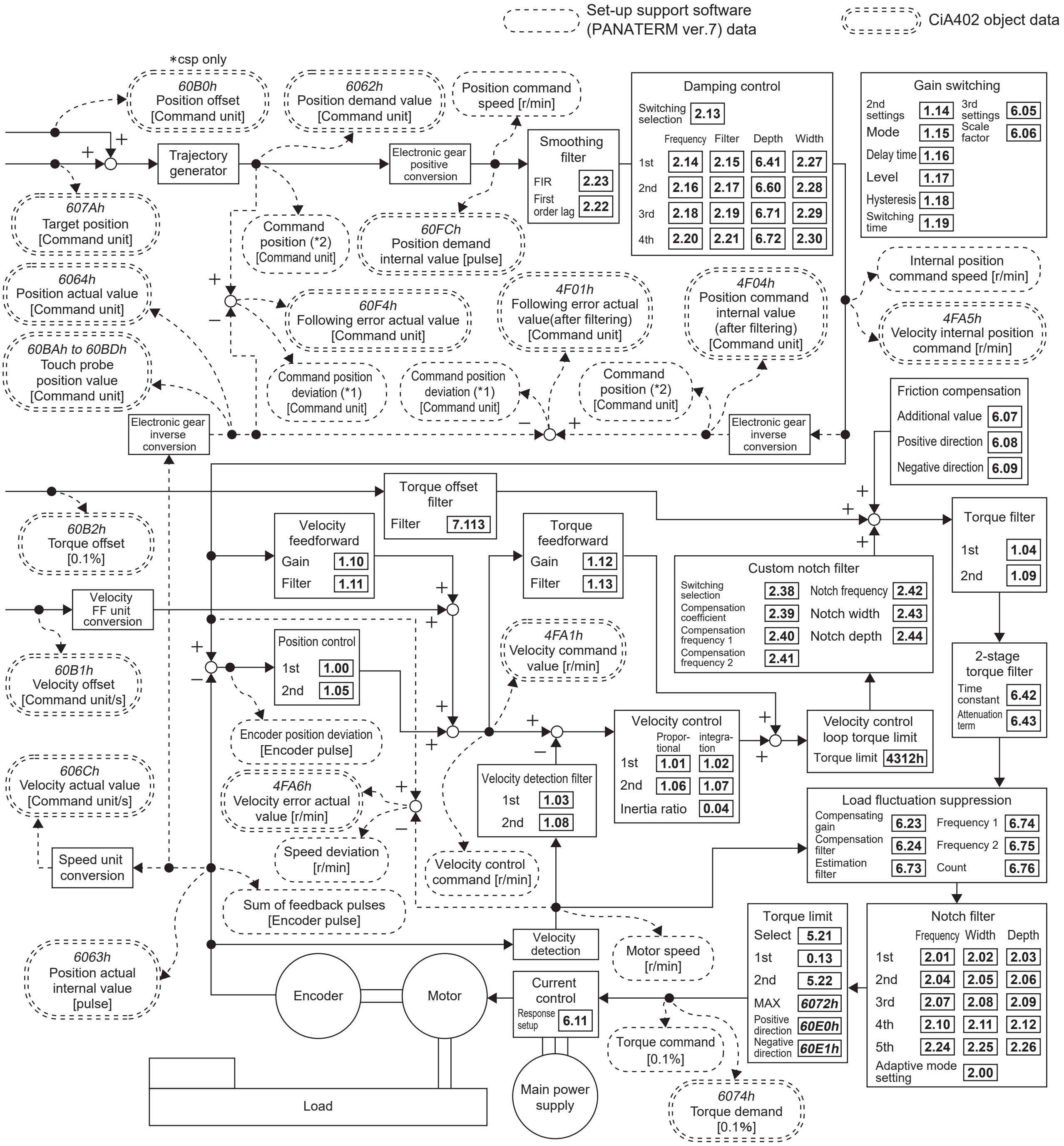
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Enables and disables two-degree-of-freedom control mode and sets standard or synchronization type. For details, see *“7.2.5 Two-degree-of-freedom Control Mode”* . |
| 2 | 22 | B | Positional command smoothing filter | 0 to 10000 | 0.1 ms | When two-degree-of-freedom control mode is disabled, sets the time constant of the first order lag filter for the position command. For details, see Operating Instructions (Tuning). |
| 7 | 23 | B | Communication function extended setup 2 | -32768 to 32767 | — | bit 14: Position deviation [command unit] output setup<br>0: Internal command position (after filter) [command unit] - actual position [command unit]<br>1: Internal command position (before filter) [command unit] - actual position [command unit] |
| 7 | 99 | B | EtherCAT function expansion setup 6 | -32768 to 32767 | — | bit 3: Command pulse accumulated value [command unit] output setting<br>0: Before filter<br>1: After filter |
| 7 | 113 | B | Torque offset filter | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter for Obj.60B2h:00h “Torque offset” .<br>Disabled when the set value is 0 to 3. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ How to use

For settings to disable two-degree-of-freedom control, see *“How to use”* “Two-degree-of-freedom control” of *“7.2.5 Two-degree-of-freedom Control Mode”* .

## Control block diagram: Position control (when two-degree-of-freedom control mode is disabled)



*1 Methods (criteria) for calculating position deviation on Set-up Support Software (PANATERM ver.7) and on an analog monitor will vary depending on the setting for Pr7.23 “Communication function extended setup 2” :bit 14 “Command position deviation output switching” . For details, see “When switching analog monitor output signal types” in *“3.2.8 Wiring to Connector X7 (Connecting to External Monitor)”* .

*2 Position commands in Set-up Support Software (PANATERM ver.7) depend on Pr7.99 “Communication function extended setup 6” :bit 3 “Command pulse accumulated value [command unit] output setting” settings.

*3 When executing frequency characteristics (velocity closed-loop characteristics analysis, torque speed (vertical)) from Set-up Support Software (PANATERM ver.7) , the driver switches to velocity control internally.

* Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.

* Numbers in bold (e.g., **1.00**) represent servo parameter numbers.

* Some objects such as polarity are omitted.

## 7.3.4 Positioning Complete Output (INP/INP2) Function

When in positioning complete state, outputs external output signal positioning complete output (INP) or positioning complete output 2 (INP2).

Turns ON when the absolute value of the position deviation counter parameter in the position control is within the positioning complete (in-position) range set using the parameter. Furthermore, the presence and absence of position command can be specified as one of the judgment conditions.

The position deviation calculation method (standard) differs as shown below depending on the setting of Pr7.23 “Communication function extended setup 2” :bit 14 “Command position deviation output switching” .

For details, see “When switching analog monitor output signal types” in *“3.2.8 Wiring to Connector X7 (Connecting to External Monitor)”* .

—: N/A

| Pr5.20 “Position setup unit select” | Pr7.23:bit 14 | Position deviation counter value used |
|---|---|---|
| 0 | 0 | Position deviation [command unit] after filter |
| 0 | 1 | Position deviation [command unit] before filter |
| 1 | — | Encoder position deviation after filter [encoder unit]/Full-closed deviation after filter [external scale unit] |

**— Precautions —**

- The “position deviation” described in this section is for the motor control processing section (Set-up Support Software (PANATERM ver.7) , which can be found on the analog monitor), not Obj.60F4h:00h “Following error actual value” on EtherCAT communication.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control and full-closed control |

### ■ Setup value

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 31 | A | Positioning complete (In-position) range | 0 to 2097152 | Command unit | Sets the threshold value of position deviation that outputs the positioning complete signal (INP).<br>The command unit is used as the default unit but can be replaced by the encoder unit or external scale unit by using Pr5.20 “Position setup unit select” . However, in such cases, note that the unit of Pr0.14 “Position deviation excess setup” will also be changed.<br>The position deviation value can switch the command before and after the position command filter using the Pr7.23 “Communication function extended setup 2” :bit 14 setting. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 32 | A | Positioning complete (In-position) output setup | 0 to 10 | — | Selects the conditions for outputting the positioning complete signal (INP).<br>Whether or not there is a position command is determined by the command after the position command filter for setting values 1 to 5, and by the command before the position command filter for 6 to 10.<br>The position deviation value can switch the command before and after the position command filter using the Pr7.23 “Communication function extended setup 2” :bit 14 setting.<br>0: ON when the position deviation is equal to or smaller than Pr4.31 “Positioning complete (In-position) range” .<br>1, 6: The signal turns ON when there is no position command and the position deviation is smaller than Pr4.31 “Positioning complete (In-position) range” .<br>2, 7: ON when there is no position command, the zero-speed detection signal is ON, and the position deviation is equal to or smaller than Pr4.31 “Positioning complete (In-position) range” .<br>3, 8: The signal turns ON when there is no position command and the position deviation is smaller than Pr4.31 “Positioning complete (In-position) range” . Subsequently, the ON state is maintained until Pr4.33 “INP hold time” has elapsed. After the INP hold time has elapsed, the INP output is switched ON/OFF according to the position command or position deviation status at that point.<br>4, 9: ON when positioning complete judgment starts after the delay time set by Pr4.33 “INP hold time” has elapsed after the change from with to no command, there is no position command, and the position deviation is equal to or smaller than Pr4.31 “Positioning complete (In-position) range” .<br>5, 10: ON when the positioning judgment delay time set by Pr4.33 “INP hold time” has elapsed after the change from with to no position command, within positioning complete (In-position) range, and positioning complete judgment sequence starts, if there is no position command and the position deviation is equal to or smaller than Pr4.31 “Positioning complete (In-position) range” . |
| 4 | 33 | A | INP hold time | 0 to 30000 | ms | ● Sets the holding time when Pr4.32 “Positioning complete (In-position) output setup” = 3 or 8.<br>0: Holding time is maintained indefinitely. The ON state is maintained until the next positional command is received.<br>1 to 30000: ON state is maintained for the set value (ms) However, will change to OFF state if a position command is entered during the hold.<br>● Becomes positioning detection delay time if Pr4.32 “Positioning complete (In-position) output setup” = 4, 5, 9, or 10.<br>0: Positioning judgment delay time is zero. Positioning complete judgment begins immediately upon a change from “With position command” to “Without position command”.<br>1 to 30000: Positioning judgment start time is delayed by exactly the set value [ms]. However, if a position command is entered during the delay time, the delay time is reset, and after the position command becomes 0, the delay time measurement starts again from 0. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 42 | A | Positioning complete (In-position) range 2 | 0 to 2097152 | Command unit | Sets the threshold value of position deviation that outputs the positioning complete signal 2 (INP2). Regardless of Pr4.32 “Positioning complete (In-position) output setup” , INP2 always comes ON when the position deviation is less than this setting value (Not judged according to the presence or absence of a position command).<br>The command unit is used as the default unit but can be replaced by the encoder unit or external scale unit by using Pr5.20 “Position setup unit select” . However, in such cases, note that the unit of Pr0.14 “Position deviation excess setup” will also be changed.<br>The position deviation value can switch the command before and after the position command filter using the Pr7.23 “Communication function extended setup 2” :bit 14 setting. |
| 5 | 20 | C | Position setup unit select | 0 to 1 | — | Selects setup units for positioning complete (In-position) range and position deviation excess.<br>0: Command unit<br>1: Encoder unit (external scale unit)<br>**— Precautions —**<br>● The EtherCAT communication positioning complete detection threshold value (Obj.6041h:bit 10 “target reached” ) is always in command units regardless of this setup value. |
| 7 | 23 | B | Communication function extended setup 2 | -32768 to 32767 | — | bit 14: Position deviation [command unit] output setup<br>0: Internal command position (after filter) [command unit] - actual position [command unit]<br>1: Internal command position (before filter) [command unit] - actual position [command unit] |

*1 For attributes, see *“6.2 Object Dictionary List”* .

# 7.4 Velocity Control

## 7.4.1 Velocity Control Overview

The following types of velocity control mode are available:

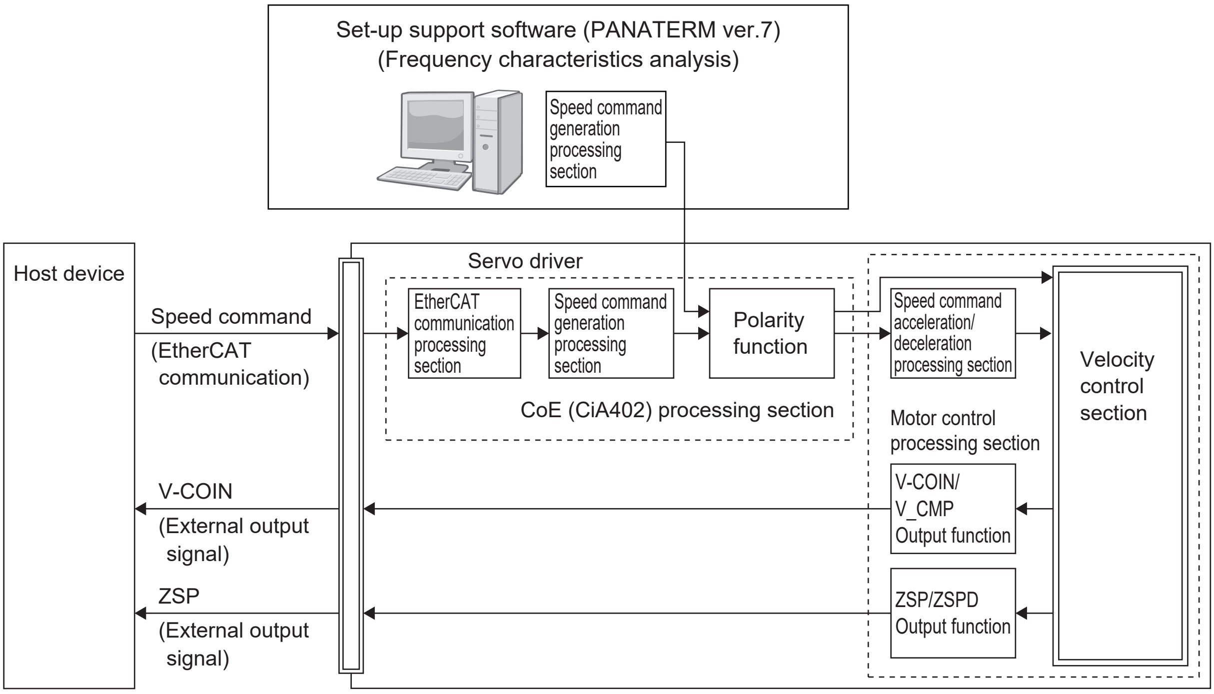
- Profile velocity control (pv):

  This is a velocity control mode in which the host device designates the target speed and acceleration/deceleration, and operates by generating position commands inside the servo driver.
- Cyclic velocity control (csv):

  This is a velocity control mode in which the host device generates a speed command, and operates by updating (sending) a position in a command speed communication cycle.

For details on velocity control, see *"6.6.6 Velocity Control Function (pv, csv)"* .

A velocity control system overview is shown below.



**— Precautions —**

- To prevent sudden motor movement, see Operating Instructions (Tuning).
- When the motor speed reaches the velocity set in Pr4.36 “At-speed (Speed arrival)” , the speed arrival output (AT-SPEED) signal, which is an external output signal, is output.

  For details, see *“7.4.4 Speed Arrival Output (AT-SPEED)”* .
- If the speed command (before the acceleration/deceleration process) and motor speed match, a velocity coincidence output (V-COIN), which is an external signal, is output.

  For details, see *“7.4.5 Velocity Coincidence Output (V-COIN)”* .
- Control mode is forcibly switched inside this product according to its operation status, regardless of commands from the host device. Because this operation also affects input signal assignments, it is generally recommended to assign the same function to each terminal in all modes.

  The conditions for forcibly switching control modes are shown below.

| Operation status if this product | Control mode after forced switching |
|---|---|
| When using Set-up Support Software (PANATERM ver.7) to perform frequency characteristics analysis | ● During position loop characteristics analysis: Position control<br>● During velocity closed-loop characteristics analysis: Velocity control<br>● During torque speed (automatic) analysis: Position control<br>● During torque speed (vertical) analysis: Velocity control<br>● During torque speed (normal) analysis: Torque control |
| During trial run via Set-up Support Software (PANATERM ver.7) | ● Position control |
| Operations with descriptions of “forcible position control” using various deceleration to stop functions ( *“8.12”* to *“8.15”* ) | ● Position control |
| During retracting operations | ● Position control |

## 7.4.2 Velocity Control (Two-degree-of-freedom Control Mode Enabled)

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Velocity control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally. |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Enables and disables two-degree-of-freedom control mode and sets standard or synchronization type. For details, see *"7.2.5 Two-degree-of-freedom Control Mode"* . |
| 2 | 22 | B | Positional command smoothing filter | 0 to 10000 | 0.1 ms | Sets the time constant of the "command response filter" when two-degree-of-freedom control mode is enabled.<br>● Maximum value is limited to 640 (= 64.0 ms).<br>**Notes**<br>● The parameter value itself is not limited, but the value applied in this product is limited.<br>● Decrease this parameter to speed up the command response, and increase it to slow down the command response. |
| 2 | 38 | B | Filter function switching | -32768 to 32767 | — | Enables or disables the filter function.<br>bit 0: Custom notch filter<br>0: Disabled<br>1: Enabled<br>bit 1: Tuning filter 2<br>0: Disabled<br>1: Enabled<br>*Do not switch tuning filter 2 between enabled and disabled during operation. |
| 2 | 39 | B | Custom notch compensation coefficient | 0 to 1000 | 0.01 | Sets the custom notch compensation coefficient. A set value of 100 or less disables compensation. |
| 2 | 40 | B | Custom notch compensation frequency 1 | 0 to 10000 | 0.1 Hz | Sets custom notch compensation frequency 1. A setup value of 0 disables compensation. |
| 2 | 41 | B | Custom notch compensation frequency 2 | 0 to 10000 | 0.1 Hz | Sets custom notch compensation frequency 2. A setup value of 0 disables compensation. |
| 2 | 42 | B | Custom notch frequency | 10 to 5000 | Hz | Sets the notch frequency of the custom notch filter.<br>A setup value of 5000 disables the custom notch filter. |
| 2 | 43 | B | Custom notch width | 0 to 20 | — | Sets the notch width of the custom notch filter. |
| 2 | 44 | B | Custom notch depth | 0 to 99 | — | Sets the notch depth of the custom notch filter. |

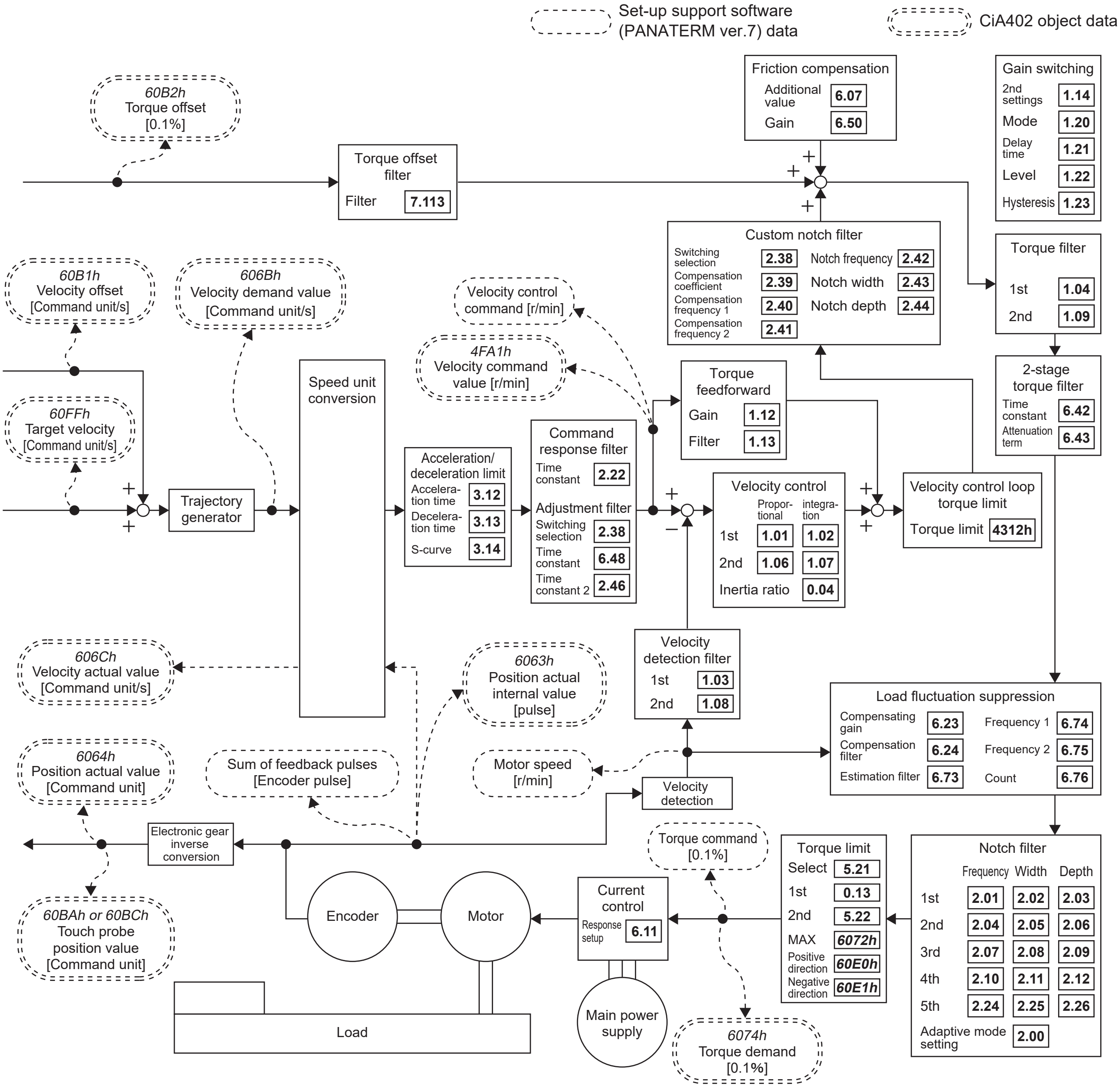
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 2 | 46 | B | Tuning filter 2 | 0 to 20000 | 0.01 ms | Sets the time constant of "Tuning filter 2" during two-degree-of-freedom control.<br>Disabled when the set value is 0 to 3.<br>● Attenuation terms are set using Pr6.49 "Command response/tuning filter attenuation term" . |
| 6 | 48 | B | Tuning filter | 0 to 2000 | 0.1 ms | Sets the time constant of the "tuning filter" in the two-degree-of-freedom control.<br>● When changing the torque filter setup, see the real-time auto tuning setting, and set a value close thereto.<br>● During velocity control, Maximum value is limited to 640 (= 64.0 ms).<br>The parameter value itself is not limited, but the value applied in this product is limited. |
| 6 | 49 | B | Command response/tuning filter attenuation term | 0 to 99 | — | Sets the "command response filter" and "tuning filter" attenuation terms in the two-degree-of-freedom control.<br>● Sets each filter in decimal notation.<br>Ones: Command response filter<br>Tens: Tuning filter<br><Target digit setting values><br>0 to 4: No attenuation terms (operates as first order lag filter)<br>5 to 9: Attenuation term ζ is 1.0, 0.86, 0.71, 0.50, 0.35, in that order (operates as second order lag filter)<br>＜ Example of this parameter setup ＞<br>To set the command response filter to ζ = 1.0 and the tuning filter to ζ = 0.71, set the setting value to 75 (ones = 5 (ζ = 1.0), tens = 7 (ζ = 0.71)).<br>Note that Pr2.22 "Positional command smoothing filter" is applied to the command response filter time constant. |
| 7 | 113 | B | Torque offset filter | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter for Obj.60B2h:00h "Torque offset" .<br>Disabled when the set value is 0 to 3. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

## ■ How to use

For settings to enable two-degree-of-freedom control, see *"How to use"* "Two-degree-of-freedom control" of *"7.2.5 Two-degree-of-freedom Control Mode"* .

## Control block diagram: Velocity control (when two-degree-of-freedom control mode is enabled)



*1 When executing a trial run, Z-phase search, or frequency characteristics (position loop characteristics) from Set-up Support Software (PANATERM ver.7) , the driver switches to position control internally.

- * Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.
- * Numbers in bold (e.g., **1.00**) represent servo parameter numbers.
- * Some objects such as polarity are omitted.

## 7.4.3 Velocity Control (Two-degree-of-freedom Control Mode Disabled)

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Velocity control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally. |

### ■ Setup value

—: None

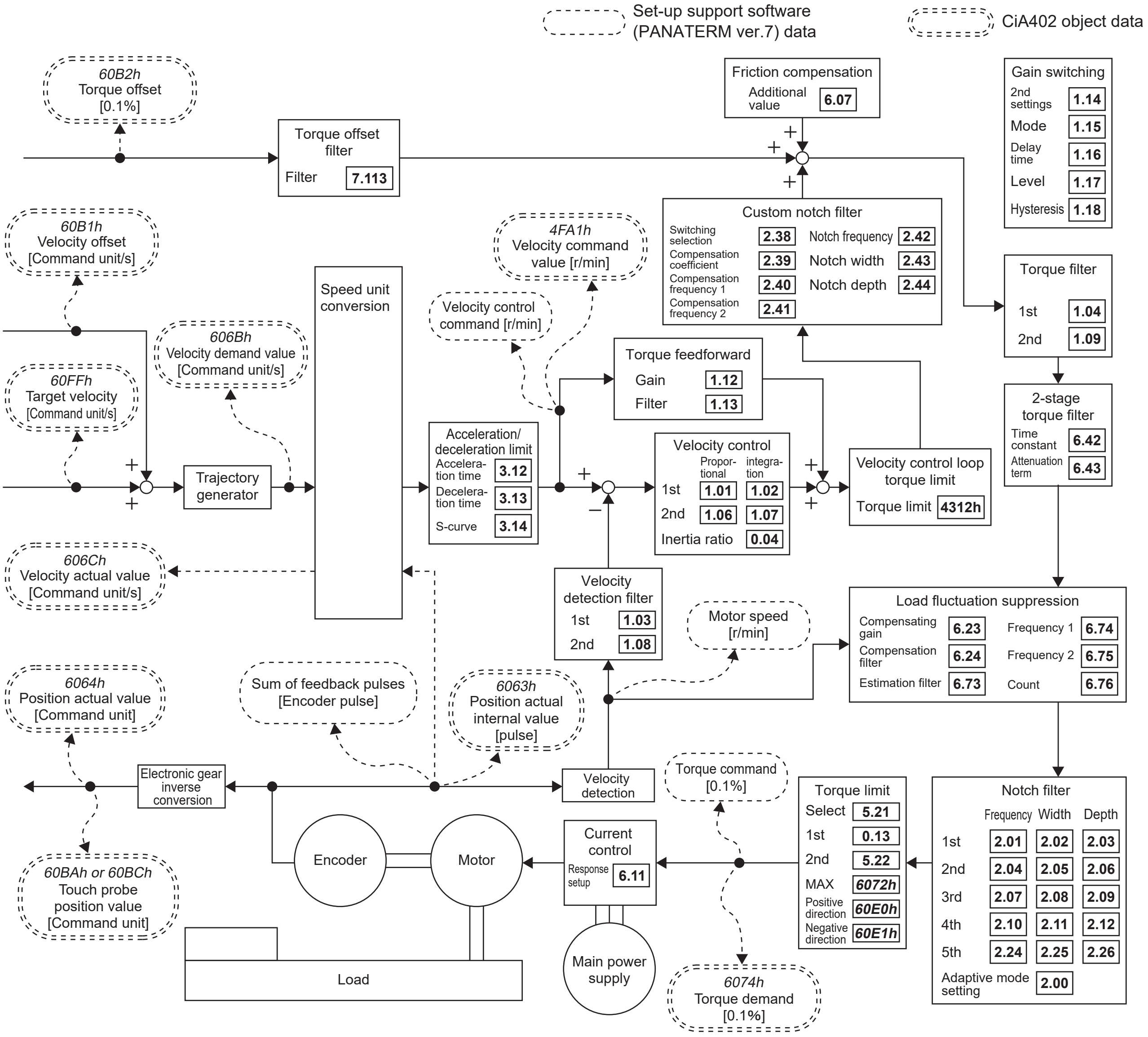
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Enables and disables two-degree-of-freedom control mode and sets standard or synchronization type. For details, see *“7.2.5 Two-degree-of-freedom Control Mode”* . |
| 7 | 113 | B | Torque offset filter | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter for Obj.60B2h:00h “Torque offset” .<br>Disabled when the set value is 0 to 3. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ How to use

For settings to disable two-degree-of-freedom control, see *“How to use”* “Two-degree-of-freedom control” of *“7.2.5 Two-degree-of-freedom Control Mode”* .

## Control block diagram: Velocity control (when two-degree-of-freedom control mode is disabled)



*1 When executing frequency characteristics (velocity closed-loop characteristics analysis, torque speed (vertical)) from Set-up Support Software (PANATERM ver.7) , the driver switches to velocity control internally.

- * Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.
- * Numbers in bold (e.g., **1.00**) represent servo parameter numbers.
- * Some objects such as polarity are omitted.

## 7.4.4 Speed Arrival Output (AT-SPEED)

When the motor speed exceeds the speed set in Pr4.36 "At-speed (Speed arrival)" , the speed arrival output (AT-SPEED) is output.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Velocity control, torque control |

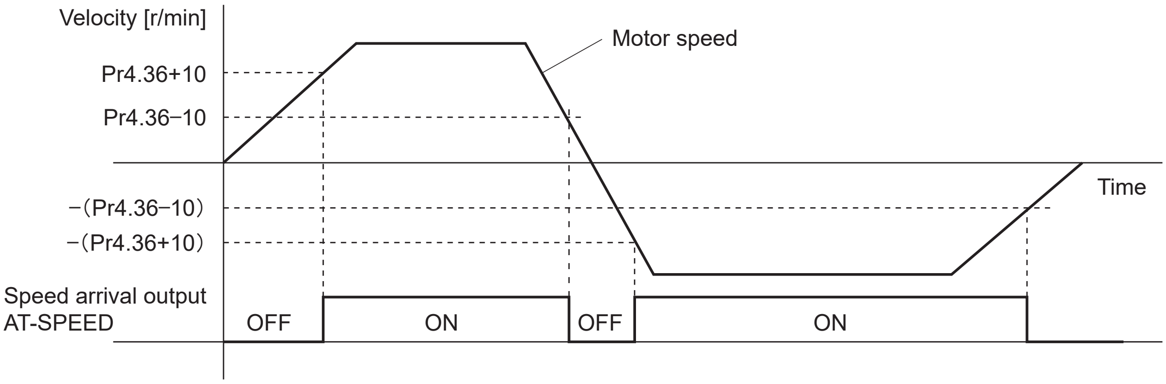
### ■ Setup value

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 36 | A | At-speed (Speed arrival) | 10 to 20000 | r/min | Sets the detection threshold value for speed arrival output (AT-SPEED).<br>When the motor speed exceeds this set value, the speed arrival output (AT-SPEED) is output.<br>Detection is associated with 10 r/min hysteresis. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

### ■ Operation

The relationship between motor speed and speed arrival output (AT-SPEED) is as follows.



## 7.4.5 Velocity Coincidence Output (V-COIN)

If the speed command (before the acceleration/deceleration process) and motor speed match, a velocity coincidence output (V-COIN), which is an external signal, is output. A match is judged if the difference between the speed command from before the acceleration/deceleration process inside the driver and the motor speed is within Pr4.35 “Speed coincidence range” .

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Velocity control, torque control |

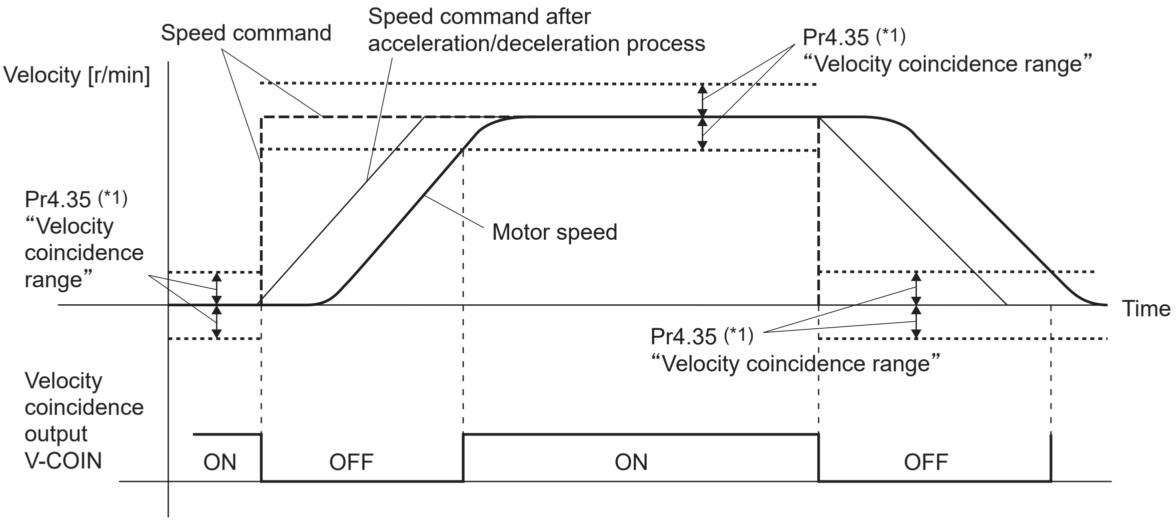
### ■ Setup value

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 35 | A | Speed coincidence range | 10 to 20000 | r/min | Sets the detection threshold value for speed coincidence output (V-COIN).<br>If the difference between speed command and motor speed is less than this setting value, outputs velocity coincidence output (V-COIN).<br>Detection may cause 10 r/min hysteresis. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Operation

The relationship between motor speed and velocity coincidence output (V-COIN) is as follows.



*1 Because the speed coincidence detection is associated with 10 r/min hysteresis, actual detection range is as shown below.

Velocity coincidence output Threshold value when OFF -> ON (Pr4.35 + -10) r/min

Velocity coincidence output Threshold value when ON -> OFF (Pr4.35 + 10) r/min

# 7.5 Torque Control

## 7.5.1 Torque Control Overview

The following types of torque control mode are available.

- Profile torque control (tq):

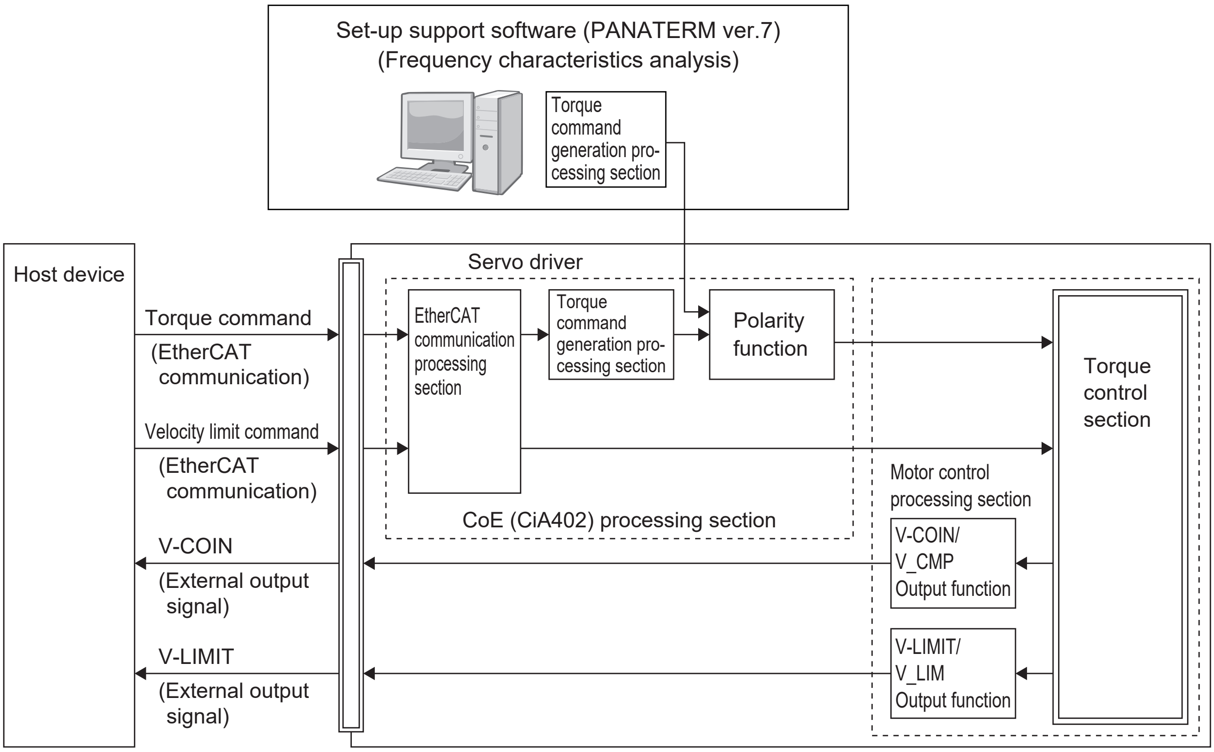
  This is a torque control mode in which the host device designates the target torque, and acceleration/deceleration, and operates by generating position commands inside the servo driver.
- Cyclic torque control (cst):

  This is a torque control mode in which the host device generates a torque command, and operates by updating (sending) the command torque at the communication cycle.

For details on torque control, see *“6.6.7 Torque Control Function (tq, cst)”* .

For torque control, a velocity limit command is required in addition to the torque command. The limit controls the rotational speed of the motor so that it does not exceed the velocity limit value.

A torque control system overview is shown below.



* The velocity coincidence output (V-COIN) has the same specifications as those for velocity control.

* The velocity limit output (V-LIMIT) outputs the same signal as the velocity coincidence output (V-COIN).

**— Precautions —**

- When commands are issued that pass through zero, such as when a torque command goes from a positive value to a negative value or a negative value to a positive value when the torque filter is enabled, the torque slope and torque filter set values may not be realized.
- Control mode is forcibly switched inside this product according to its operation status, regardless of commands from the host device. Because this operation also affects input signal assignments, it is generally recommended to assign the same function to each terminal in all modes.

  The conditions for forcibly switching control modes are shown below.

| Operation status if this product | Control mode after forced switching |
|---|---|
| When using Set-up Support Software (PANATERM ver.7) to perform frequency characteristics analysis | ● During position loop characteristics analysis: Position control<br>● During velocity closed-loop characteristics analysis: Velocity control<br>● During torque speed (automatic) analysis: Position control<br>● During torque speed (vertical) analysis: Velocity control<br>● During torque speed (normal) analysis: Torque control |
| During trial run via Set-up Support Software (PANATERM ver.7) | ● Position control |
| Operations with descriptions of “forcible position control” using various deceleration to stop functions ( *“8.12”* to *“8.15”* ) | ● Position control |
| During retracting operations | ● Position control |

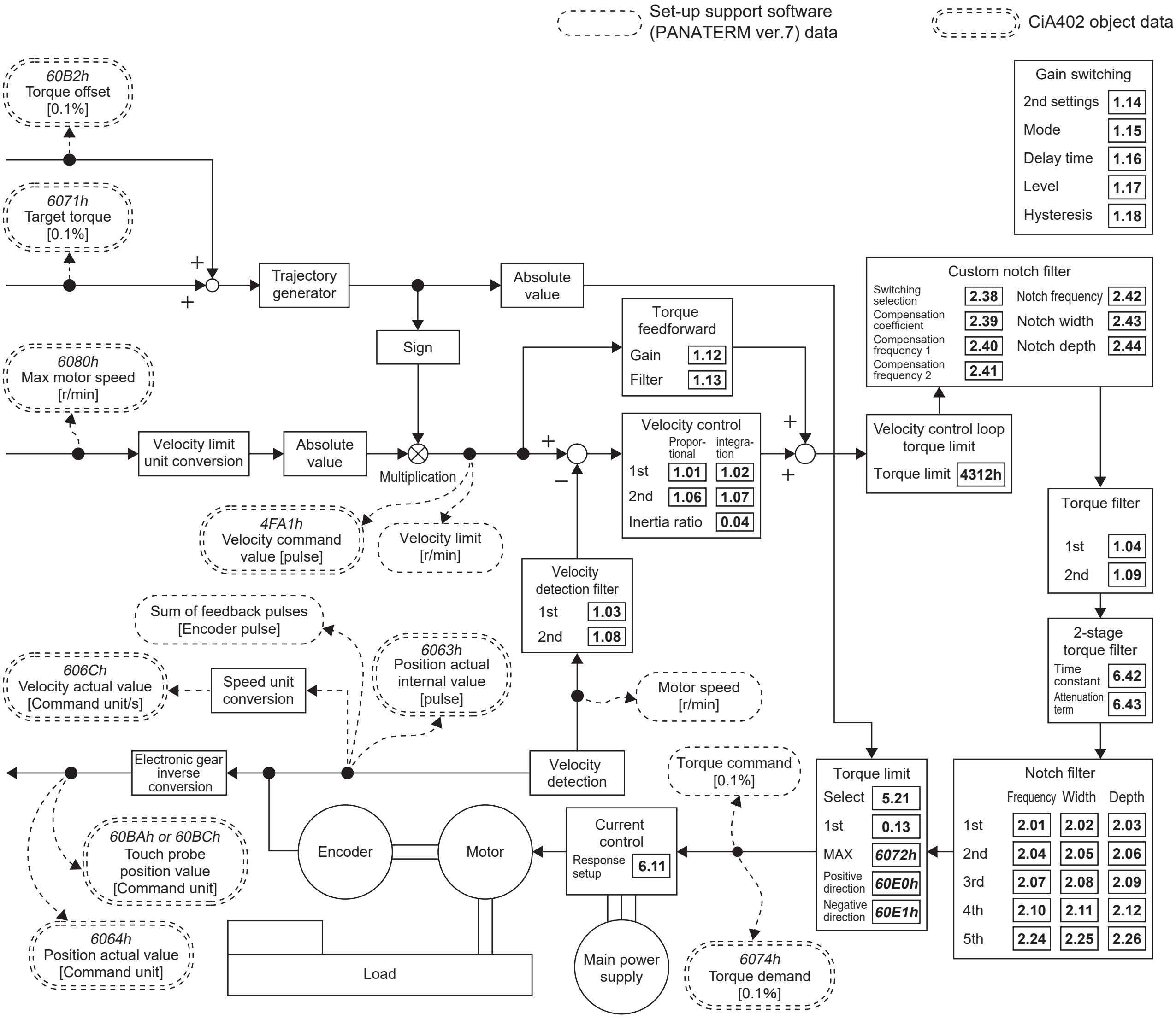
## ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Torque control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally. |

## ■ Setup value

Torque control requires a velocity limit command. For setting values, see *“7.5.2 Velocity Limit Function”* .

## Control block diagram: Torque control



*1 When executing frequency characteristics (torque speed (normal)) from Set-up Support Software (PANATERM ver.7) , the driver switches to velocity control internally.

- * Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.
- * Numbers in bold (e.g., **1.00**) represent servo parameter numbers.
- * Some objects such as polarity are omitted.

## 7.5.2 Velocity Limit Function

Limits velocity as protection during torque control.

Provides control to ensure that the velocity does not exceed the velocity limit value set during torque control.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Torque control |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 3 | 17 | B | Selection of speed limit | 2 | — | Sets the velocity limit value selection method during torque control.<br>In this product, it will be fixed to 2 (Obj.6080h:00h “Max motor speed” ). |
| 6 | 97 | B | Function expansion setup 3 | -2147483648 to 2147483647 | — | bit 12: Speed limit priority function during torque control<br>0: Torque command priority<br>1: Velocity limit priority<br>bit 12 = 1 (Speed limit priority) is only enabled for cyclic torque control mode (cst).<br>With velocity limit priority, if Obj.606Ch:00h “Velocity actual value” exceeds the velocity limit value (Obj.607Fh:00h “Max profile velocity” or Obj.6080h:00h “Max motor speed” ), the torque limit is disabled by Obj.60E0h:00h “Positive torque limit value” or Obj.60E1h:00h “Negative torque limit value” and the required torque is generated and controlled such that the velocity does not exceed the limit value. However, the maximum motor torque will be Obj.6072h:00h “Max torque” . |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Precautions

- While being controlled by the velocity limit, torque commands to the motor do not follow torque commands from the host device. The torque commands to the motor are the result of velocity control provided so that the motor speed reaches the velocity limit value.
- If the motor is operating in the opposite direction to the torque command from the host device due to disturbances such as gravity, the velocity limit may not function.

  If this operation becomes a problem, set the velocity at which to stop the motor in Pr5.13 “Over-speed level setup” or Pr6.15 “2nd overspeed level setting” , and stop the motor if Err26.0.0 “Overspeed protection” or Err26.1.0 “2nd Overspeed protection” occurs.

  For details on overspeed protection, see *“8.16 Emergency Stop Function for When Alarm is Triggered”* .

## 7.6 Full-closed Control

### 7.6.1 Full-closed Control Overview

Full-closed control is a type of position control that uses an external scale to directly detect the position of the machine to be controlled and provide feedback. For example, it can provide control that is not affected by ball screw errors or position fluctuations due to temperature.

Constructing a full-closed control system makes it possible to achieve high-precision positioning on the order of submicrons.

Full-closed control is available for profile position control mode (pp), cyclic position control mode (csp), and homing position control mode (hm).

For details on full-closed control, see *"6.6.5 Position Control Function (pp, csp, ip, hm)"* .

When using full-closed control, it is not possible to switch from position control mode (pp, csp, hm) to velocity control mode (profile velocity control (pv), cyclic velocity control (csv)) or torque control mode (profile torque control (tq), cyclic torque control (cst)).

With full-closed control, if Obj.6060h:00h "Modes of operation" is set to 3 (pv), 4 (tq), 9 (csv), or 10 (cst), Err88.1.0 "Control mode setting error protection" will occur.

For setting up the external scale ratio and hybrid deviation excess in the initial full-closed control setting, see *"7.6.4 External Scale Dividing Ratio Settings"* and *"7.6.5 Hybrid Deviation Excess Setup"* .

**— Precautions —**

- One command pulse (one command unit) when using an electronic gear ratio of 1/1 is one pulse for the external scale.

  In full-closed control, velocity control is performed by encoder feedback, and position control is performed by external scale feedback.
- Set Pr3.28 "Hybrid deviation excess setup" and Pr3.29 "Hybrid deviation clear setup" to appropriate values.

  If the excessive hybrid deviation range is set too wide, these detections will be delayed and the effect of anomaly detection will be lost. On the other hand, if the range is too small, the amount of motor or machine torsion generated during normal operation may be detected as an error. For details, see *"7.6.5 Hybrid Deviation Excess Setup"* .
- An external scale of 1/40 ≦ External scale ratio ≦ 20480 is recommended.

  Setting the external scale ratio to a smaller value than 50/position loop gain [Hz] may prevent control of the external scale in single pulse units.

  Increasing the external scale ratio may increase noise during operation.
- Using an incorrect external scale dividing ratio may trigger Err25.0.0 "Hybrid deviation excess protection" , especially when using a long stroke distance, even if the external scale and motor position are matched. In such cases, adjust the external scale dividing ratio to a value as close as possible and widen the excessive hybrid deviation range.

## 7.6.2 Full-closed Control (Two-degree-of-freedom Control Mode Enabled)

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Full-closed control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally.<br>● Driver type must be one other than standard type.<br>● For precautions for full-closed control, see *“7.6.1 Full-closed Control Overview”* . |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Enables and disables two-degree-of-freedom control mode and sets standard or synchronization type. For details, see *“7.2.5 Two-degree-of-freedom Control Mode”* . |
| 2 | 22 | B | Positional command smoothing filter | 0 to 10000 | 0.1 ms | Sets the time constant of the “command response filter” when two-degree-of-freedom control mode is enabled.<br>● Maximum value is limited to 2000 (= 200.0 ms).<br>**Notes**<br>● The parameter value itself is not limited, but the value applied in this product is limited.<br>● Decrease this parameter to speed up the command response, and increase it to slow down the command response.<br>● Attenuation terms are set using Pr6.49 “Command response/tuning filter attenuation term” . |
| 2 | 38 | B | Filter function switching | -32768 to 32767 | — | Enables or disables the filter function.<br>bit 0: Custom notch filter<br>0: Disabled<br>1: Enabled<br>bit 1: Tuning filter 2<br>0: Disabled<br>1: Enabled<br>*Do not switch tuning filter 2 between enabled and disabled during operation. |
| 2 | 39 | B | Custom notch compensation coefficient | 0 to 1000 | 0.01 | Sets the custom notch compensation coefficient. A set value of 100 or less disables compensation. |
| 2 | 40 | B | Custom notch compensation frequency 1 | 0 to 10000 | 0.1 Hz | Sets custom notch compensation frequency 1. A setup value of 0 disables compensation. |
| 2 | 41 | B | Custom notch compensation frequency 2 | 0 to 10000 | 0.1 Hz | Sets custom notch compensation frequency 2. A setup value of 0 disables compensation. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 2 | 42 | B | Custom notch frequency | 10 to 5000 | Hz | Sets the notch frequency of the custom notch filter.<br>A setup value of 5000 disables the custom notch filter. |
| 2 | 43 | B | Custom notch width | 0 to 20 | — | Sets the notch width of the custom notch filter. |
| 2 | 44 | B | Custom notch depth | 0 to 99 | — | Sets the notch depth of the custom notch filter. |
| 2 | 46 | B | Tuning filter 2 | 0 to 20000 | 0.01 ms | Sets the time constant of "Tuning filter 2" during two-degree-of-freedom control.<br>Disabled when the set value is 0 to 3.<br>● Attenuation terms are set using Pr6.49 "Command response/tuning filter attenuation term" . |
| 6 | 48 | B | Tuning filter | 0 to 2000 | 0.1 ms | Sets the time constant of the "tuning filter" in the two-degree-of-freedom control.<br>● When changing the torque filter setup, see the real-time auto tuning setting, and set a value close thereto.<br>● Finely tuning by checking the encoder position deviation of the settling area may improve overshoot or oscillatory waveform.<br>● Attenuation terms are set using Pr6.49 "Command response/tuning filter attenuation term" . |
| 6 | 49 | B | Command response/tuning filter attenuation term | 0 to 99 | — | Sets the "command response filter" and "tuning filter" attenuation terms in the two-degree-of-freedom control.<br>● Sets each filter in decimal notation.<br>Ones: Command response filter<br>Tens: Tuning filter<br><Target digit setting values><br>0 to 4: No attenuation terms (operates as first order lag filter)<br>5 to 9: Attenuation term ζ is 1.0, 0.86, 0.71, 0.50, 0.35, in that order (operates as second order lag filter)<br>＜ Example of this parameter setup ＞<br>To set the command response filter to ζ = 1.0 and the tuning filter to ζ = 0.71, set the setting value to 75 (ones = 5 (ζ = 1.0), tens = 7 (ζ = 0.71)).<br>Note that Pr2.22 "Positional command smoothing filter" is applied to the command response filter time constant. |
| 6 | 50 | B | Viscous friction compensating gain | 0 to 10000 | 0.1 %/ (10000 r/min) | When the two-degree-of-freedom control mode is enabled, the product of the command speed and the setup value is used as the viscous friction torque compensation and the torque command is added to the torque.<br>● Setting the value of the viscous friction coefficient estimation of real-time auto tuning can improve the encoder position deviation of the settling area. |

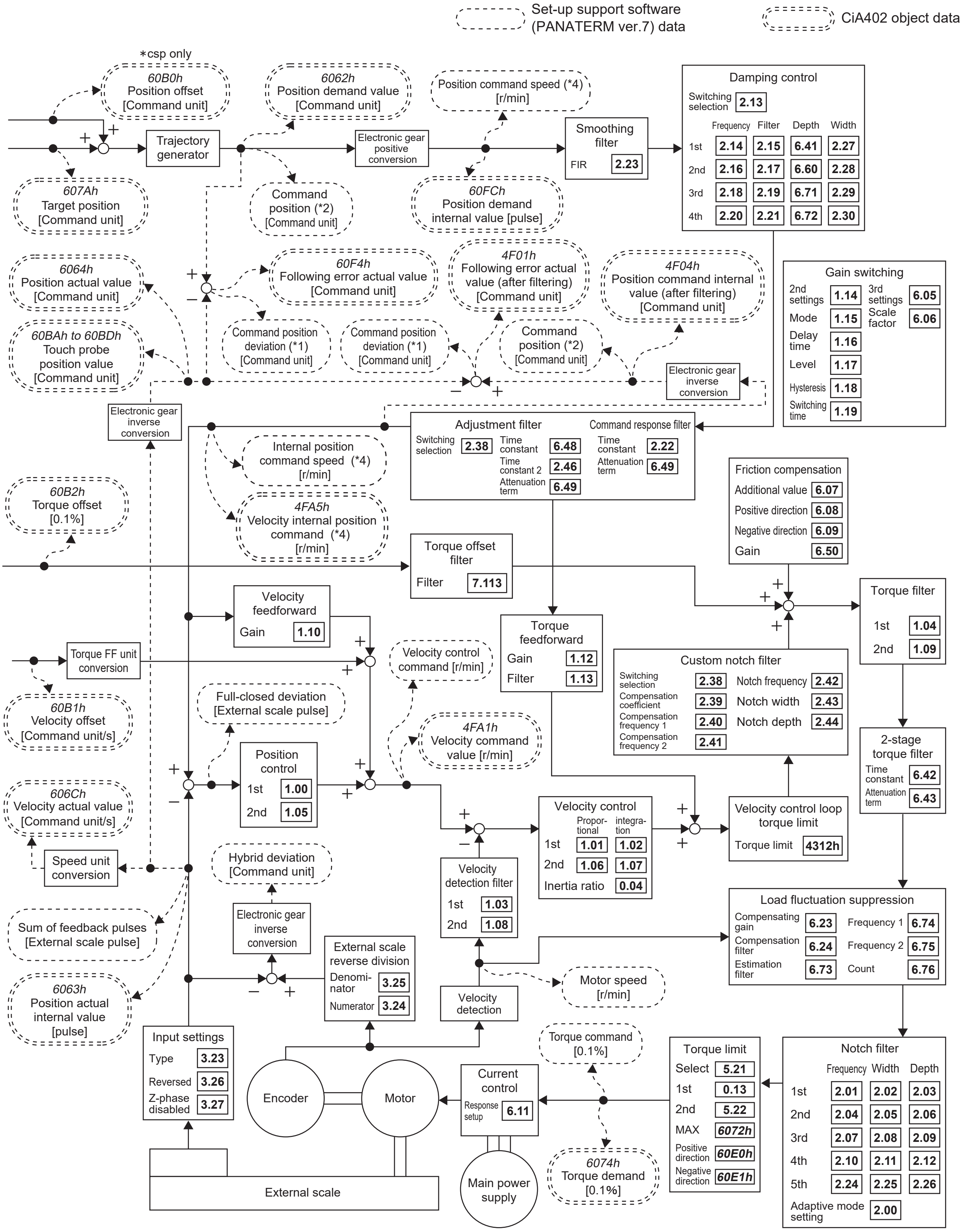
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 7 | 23 | B | Communication function extended setup 2 | -32768 to 32767 | — | bit 14: Position deviation [command unit] output setup<br>0: Internal command position (after filter) [command unit] - actual position [command unit]<br>1: Internal command position (before filter) [command unit] - actual position [command unit] |
| 7 | 99 | B | EtherCAT function expansion setup 6 | -32768 to 32767 | — | bit 3: Command pulse accumulated value [command unit] output setting<br>0: Before filter<br>1: After filter |
| 7 | 113 | B | Torque offset filter | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter for Obj.60B2h:00h “Torque offset” .<br>Disabled when the set value is 0 to 3. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ How to use

For settings to enable two-degree-of-freedom control, see *“How to use”* “Two-degree-of-freedom control” of *“7.2.5 Two-degree-of-freedom Control Mode”* .

## Control block diagram: Full-closed control (when two-degree-of-freedom control mode is enabled)



*1 Methods (criteria) for calculating position deviation on Set-up Support Software (PANATERM ver.7) and on an analog monitor will vary depending on the setting for Pr7.23 “Communication function extended setup 2” :bit 14 “Command position deviation output switching” . For details, see “When switching analog monitor output signal types” in *“3.2.8 Wiring to Connector X7 (Connecting to External Monitor)”* .

*2 Position commands in Set-up Support Software (PANATERM ver.7) depend on Pr7.99 “Communication function extended setup 6” :bit 3 “Command pulse accumulated value [command unit] output setting” settings.

*3 When executing a trial run, Z-phase search, or frequency characteristics (position loop characteristics) from Set-up Support Software (PANATERM ver.7) , the driver switches to position control internally.

*4 Velocity [r/min] unit calculated from encoder, not external scale.

- Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.
- Numbers in bold (e.g., **1.00**) represent servo parameter numbers.
- Some objects such as polarity are omitted.

## 7.6.3 Full-closed Control (Two-degree-of-freedom Control Mode Disabled)

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Full-closed control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor operates normally.<br>● Driver type must be one other than standard type.<br>● For precautions for full-closed control, see *"7.6.1 Full-closed Control Overview"* . |

### ■ Setup value

—: None

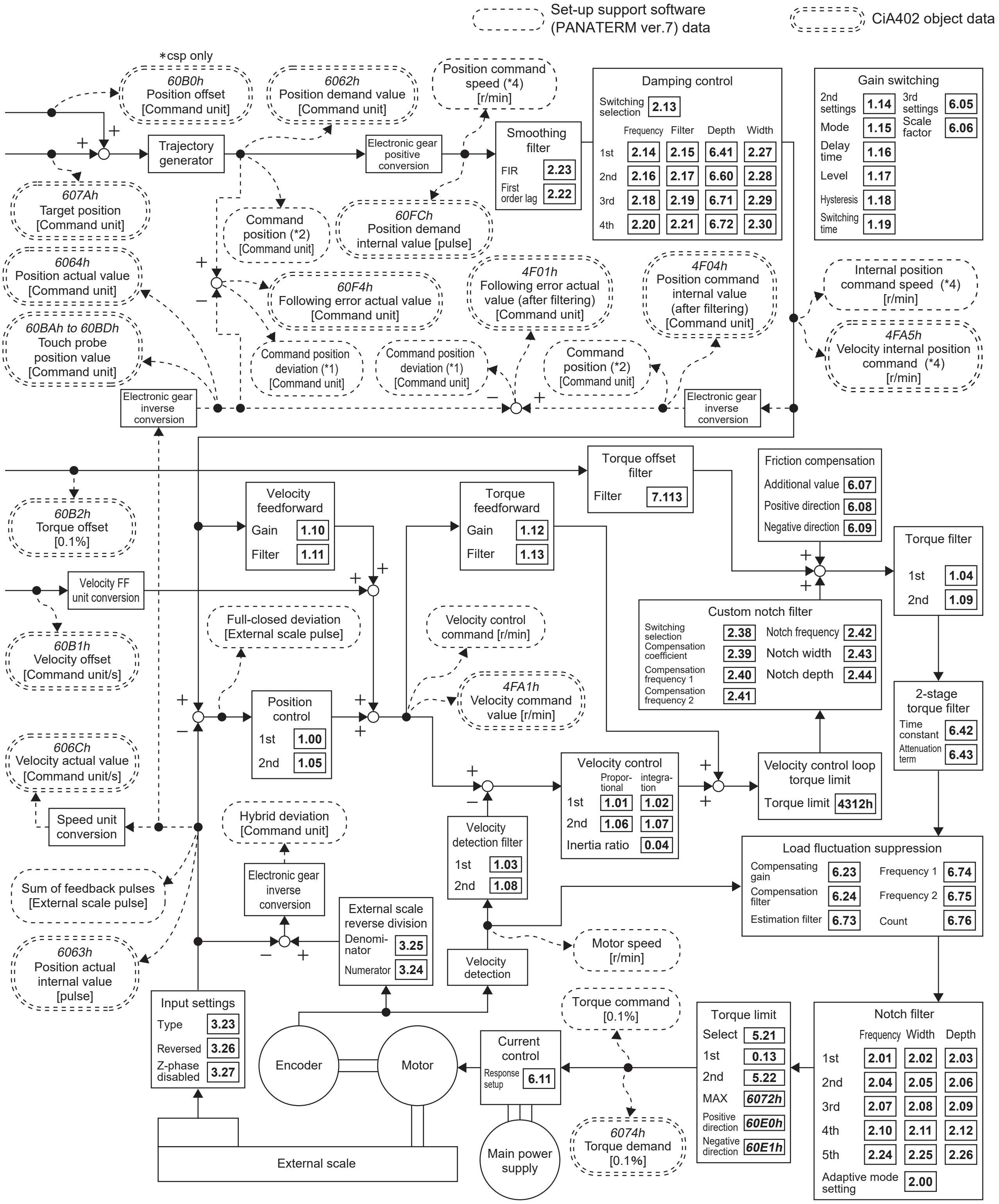
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | Enables and disables two-degree-of-freedom control mode and sets standard or synchronization type. For details, see *"7.2.5 Two-degree-of-freedom Control Mode"* . |
| 2 | 22 | B | Positional command smoothing filter | 0 to 10000 | 0.1 ms | When two-degree-of-freedom control mode is disabled, sets the time constant of the first order lag filter for the position command. For details, see Operating Instructions (Tuning). |
| 7 | 23 | B | Communication function extended setup 2 | -32768 to 32767 | — | bit 14: Position deviation [command unit] output setup<br>0: Internal command position (after filter) [command unit] - actual position [command unit]<br>1: Internal command position (before filter) [command unit] - actual position [command unit] |
| 7 | 99 | B | EtherCAT function expansion setup 6 | -32768 to 32767 | — | bit 3: Command pulse accumulated value [command unit] output setting<br>0: Before filter<br>1: After filter |
| 7 | 113 | B | Torque offset filter | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter for Obj.60B2h:00h "Torque offset" .<br>Disabled when the set value is 0 to 3. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

### ■ How to use

For settings to disable two-degree-of-freedom control, see *"How to use"* "Two-degree-of-freedom control" of *"7.2.5 Two-degree-of-freedom Control Mode"* .

## Control block diagram: Full-closed control (when two-degree-of-freedom control mode is disabled)



*1 Position deviation [command unit] operation criteria in Set-up Support Software (PANATERM ver.7) can be changed with Pr7.23 “Communication function extended setup 2” :bit 14.

*2 Position commands in Set-up Support Software (PANATERM ver.7) depend on Pr7.99 “Communication function extended setup 6” :bit 3 “Command pulse accumulated value [command unit] output setting” settings.

*3 When executing a trial run, Z-phase search, or frequency characteristics (position loop characteristics) from Set-up Support Software (PANATERM ver.7) , the driver switches to position control internally.

*4 Velocity [r/min] unit calculated from encoder, not external scale.

* Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.

* Numbers in bold (e.g., **1.00**) represent servo parameter numbers.

* Some objects such as polarity are omitted.

## 7.6.4 External Scale Dividing Ratio Settings

A function that sets the dividing ratio of encoder resolution and feedback scale resolution.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Full-closed control |
| Other | ● Driver type must be one other than standard type.<br>● For precautions for full-closed control, see *"7.6.1 Full-closed Control Overview"* . |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 3 | 24 | R | Numerator of external scale division | 0 to $2^{27}$ | — | Sets numerator for external scale division setup.<br>When this setup value is 0, encoder resolution is used as the division numerator. |
| 3 | 25 | R | Denominator of external scale division | 1 to $2^{27}$ | — | Sets denominator for external scale division setup. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

### ■ How to use

Check the encoder pulse count per motor revolution and the external scale pulse count per motor revolution, and set Pr3.24 "Numerator of external scale division" and Pr3.25 "Denominator of external scale division" so that the following formula holds.

(Example) For a ball screw pitch of 10 mm, a scale of 0.1 μm/pulse, and an encoder resolution of 27 bits (134217728 pulses)

$$\text{External scale ratio} = \frac{\text{Pr3.24}\ \boxed{134217728}}{\text{Pr3.25}\ \boxed{100000}} = \frac{\text{Encoder pulse count per motor revolution [pulse]}}{\text{External scale pulse count per motor revolution [pulse]}}$$

If this ratio is wrong, the difference between the position calculated based on the encoder pulse and the position calculated based on the external scale pulse becomes large over a long travel distance and activates hybrid deviation excess error protection.

Setting Pr3.24 "Numerator of external scale division" to 0 automatically sets the encoder resolution as the numerator.

### 7.6.5 Hybrid Deviation Excess Setup

This function detects the difference between motor (encoder) position and load (external scale) position, and generates hybrid deviation excess error protection when the difference exceeds Pr3.28 “Hybrid deviation excess setup” .

Excessive hybrid deviation mainly occurs when there is an abnormality in the external scale, a wrong connection, or a loose connection between the motor and load.

#### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Full-closed control |
| Other | ● Driver type must be one other than standard type.<br>● For precautions for full-closed control, see *“7.6.1 Full-closed Control Overview”* . |

#### ■ Setup value

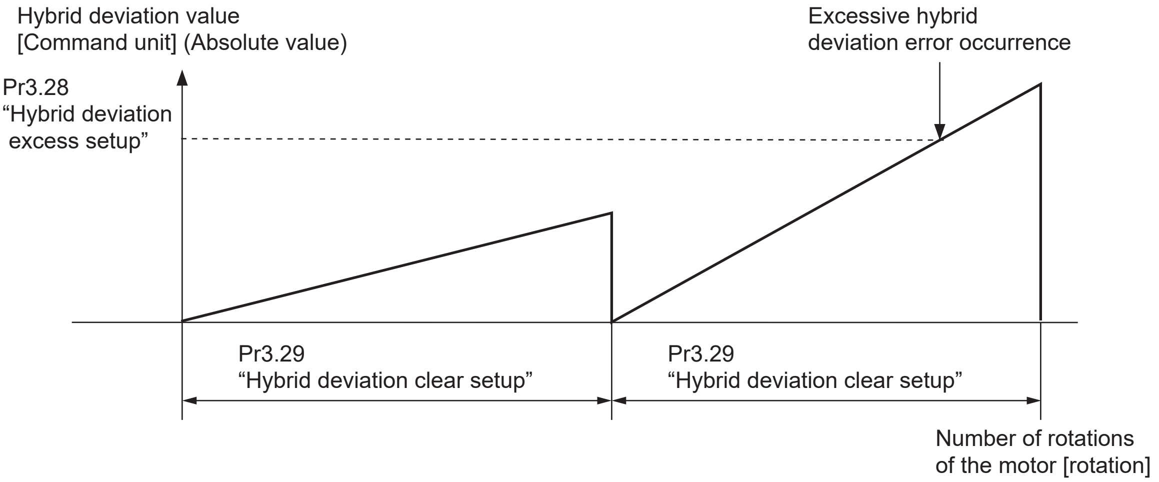
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 3 | 28 | C | Hybrid deviation excess setup | 1 to $2^{27}$ | Command unit | Sets the allowance (hybrid deviation) between motor (encoder) position and load (external scale) position in command units. |
| 3 | 29 | C | Hybrid deviation clear setup | 0 to 100 | Rotation | Clears the hybrid deviation to 0 each time the motor rotates for this setup value. If this setup value is 0, it will not clear hybrid deviation to zero using this setting. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

#### ■ How to use

- Hybrid deviation clearing

  Hybrid deviation is cleared to 0 each time the motor rotates by the number of rotations set in Pr3.29 “Hybrid deviation clear setup” . This function can also be used for applications where hybrid deviation accumulates due to slippage, etc.



* Number of rotations in the hybrid deviation clear setup is counted by using encoder feedback pulses.

**— Precautions —**

1 When using hybrid deviation clear, be sure to set Pr3.29 “Hybrid deviation clear setup” to an appropriate value. If the setting value of Pr3.28 “Hybrid deviation excess setup” is set to a small value, it may not function as a protection against abnormal operation caused by incorrect connection of the external scale.

Limit sensor should be used to assure safety.

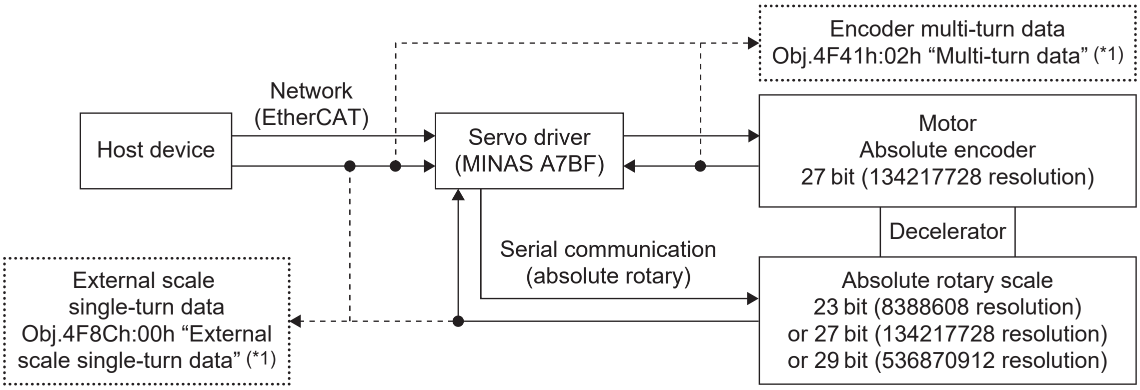
2 In addition to the above, hybrid deviation is cleared to 0 at the following position information initialization.

- Absolute system when power supply is turned on
- When homing is completed
- Upon completion of the following functions with Set-up Support Software (PANATERM ver.7)

  Trial run function, Z-phase search function, frequency characteristics analysis function (FFT function), One Minute TUNING function, Config execution, absolute encoder multi-turn data clear
- When Err27.4.0 “Position command error protection” occurs

## 7.6.6 Full-closed Control Function (Rotary Scale)

This section describes the full-closed control function when using a rotary scale.



*1 For EtherCAT objects, see Technical Reference Communication Specification "8.3 User-specific Area (4000h to 4FFFh)" .

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Cyclic position control (csp) only<br>Operations cannot be guaranteed when switching to other control modes. |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor rotates normally.<br>● The electronic gear ratio must be 1/1.<br>● Pr0.15 "Absolute encoder setup" = 0 (absolute mode).<br>● The rotary scale must be compatible with the Panasonic serial communication absolute rotary format. Also, the resolution must be 23-bit (8388608 resolution), 27-bit (134217728 resolution), or 29-bit (536870912 resolution).<br>The absolute encoder must use a 27-bit (134217728 resolution) resolution.<br>● Driver type must be one other than standard type.<br>● For details and precautions for full-closed control, see *"7.6.1 Full-closed Control Overview"* . |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 01 | R | Control mode setup | 0 to 6 | — | Selects a control mode for this product.<br>0: Semi-closed control (switchable between position/ velocity/torque control)<br>1 to 5: Manufacturer use (setting is prohibited)<br>6: Full-closed control (position control only) |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 15 | C | Absolute encoder setup | 0 to 4 | — | Sets the method of use of the absolute encoder.<br>0: Use as an absolute system (absolute mode).<br>1: Use as an incremental system (incremental mode) (Detection of the following protection functions is disabled.).<br>Err40.0.0 “Absolute system down error protection”<br>Err41.0.0 “Absolute counter over error protection”<br>Err42.0.0 “Absolute overspeed error protection”<br>Err45.0.0 “Multi-turn counter error protection”<br>2: Use as an absolute system (absolute mode), but ignore multi-turn counter overs.<br>3: Use as an absolute system (absolute mode), but do not use the multi-turn counter (Single-turn absolute mode).<br>4: Use as absolute system (absolute mode), but any value can be set for the upper-limit value of the multi-turn counter.<br>Ignore multi-turn counter overs (Continuous rotating absolute encoder mode).<br>**Notes**<br>● Set to 0 if using the full-closed control function (rotary scale). |
| 3 | 23 | R | External scale selection | 0 to 6 | — | Select the type of external scale. |

0: A/B-phase output type

1: Serial communication type (incremental)

2: Serial communication type (absolute)

3 to 5: Manufacturer use (setting is prohibited)

6: Serial communication type (absolute rotary specification)

- Please ensure the settings correspond to the type of external scale used. The table below shows the relationship between the external scale and the setting values.

| External scale type used | Set value of Pr3.23 | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3, 4, 5 | 6 |
| A/B-phase output type | Enabled | Err50.0.0 “External scale wiring error protection” is triggered | Err50.0.0 “External scale wiring error protection” is triggered | Err93.3.5 “External scale connection error protection” is triggered | Err50.0.0 “External scale wiring error protection” is triggered |
| Serial communication type (incremental) | Err55.0.0 “A-phase connection error protection” , Err55.1.0 “B-phase connection error protection” , Err55.2.0 “Z-phase connection error protection” are triggered | Enabled | Err93.3.2 “External scale connection error protection” is triggered | | Err93.3.2 “External scale connection error protection” is triggered |
| Serial communication type (absolute) | | Err93.3.1 “External scale connection error protection” is triggered | Enabled | | Err93.3.1 “External scale connection error protection” is triggered |
| Serial communication type (absolute rotary specification) | | Err93.3.3 “External scale connection error protection” is triggered | Err93.3.3 “External scale connection error protection” is triggered | | Enabled |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 3 | 24 | R | Numerator of external scale division | 0 to $2^{27}$ | – | Sets numerator for external scale division setup.<br>When this setup value is 0, encoder resolution is used as the division numerator. |
| 3 | 25 | R | Denominator of external scale division | 1 to $2^{27}$ | – | Sets denominator for external scale division setup. |
| 3 | 26 | R | Reversal of direction of external scale | 0 to 3 | – | Set the reversal of external scale feedback counter.<br>0: Not reversed<br>1: Reversed<br>2: Manufacturer use (setting is prohibited)<br>3: Manufacturer use (setting is prohibited) |
| 6 | 97 | B | Function expansion setup 3 | -2147483648 to 2147483647 | – | bit 3: Selection of external scale single-turn data monitor<br>0: Non-inverted (scale acquisition data)<br>1: Reversed<br>**Notes**<br>● This bit is enabled only when using full-closed control (rotary scale). |
| 6 | 98 | R | Function expansion setup 4 | -2147483648 to 2147483647 | – | bit 10: Selection of external scale single-turn data output format<br>Switches the external scale absolute position specification on the Set-up Support Software (PANATERM ver.7) monitor screen.<br>0: External scale absolute position<br>1: External scale single-turn data<br>**Notes**<br>● This bit is enabled only when using full-closed control (rotary scale). |
| 9 | 01 | R | Feedback scale resolution | 0 to 536870912 | pulse | Configures the resolution of the connected absolute rotary scale using the full-closed control function (rotary scale).<br>Only supports 23-bit (8388608 resolution), 27-bit (134217728 resolution), and 29-bit (536870912 resolution) absolute rotary scale. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- Calculating machine coordinates

  Machine coordinates based on encoder multi-turn data are not calculated on the product side.

  It is necessary to calculate the machine coordinates on the host device side by using EtherCAT communication to acquire the “encoder multi-turn data” and “external scale single-turn data”.

  Use the following calculation to obtain the machine coordinates.

  This example assumes a 29-bit external scale resolution (536870912 resolution) and a reduction ratio of 120, with the power supply switched on at the position indicated in the diagram below by the thick dashed line.

  1 Calculation of mechanical multi-turn data

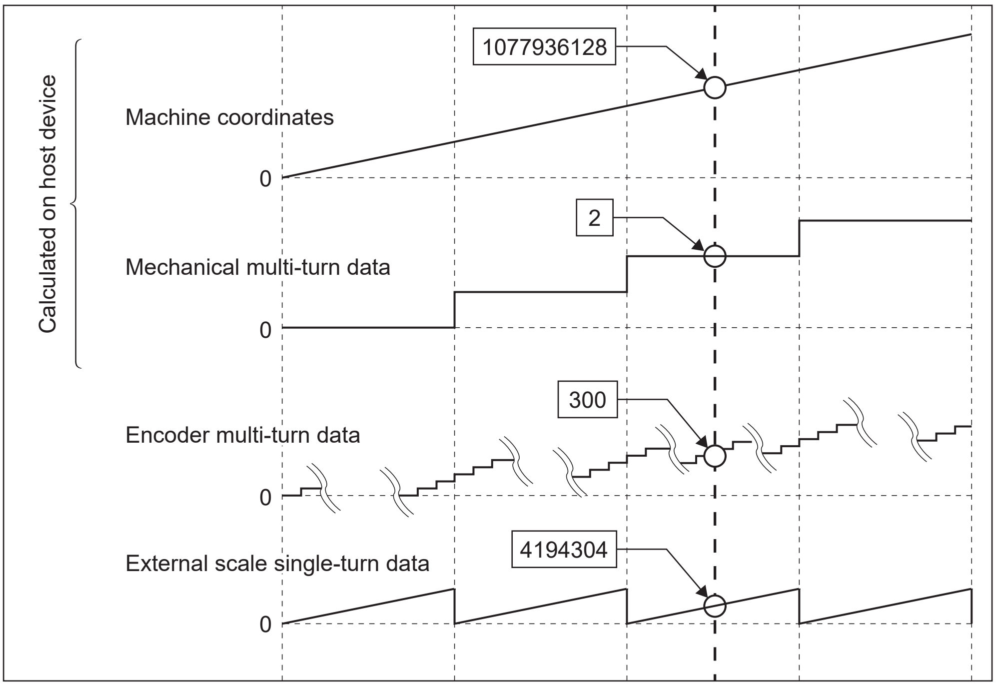
  Mechanical multi-turn data = Encoder multi-turn data/Reduction ratio

  = 300/120 = 2 (Round down to nearest decimal point)

2 Calculating machine coordinates

Machine coordinates = Feedback scale resolution × Mechanical multi-turn data + External scale single-turn data

= 536870912 × 2 + 4194304 = 1077936128



- Driver coordinates

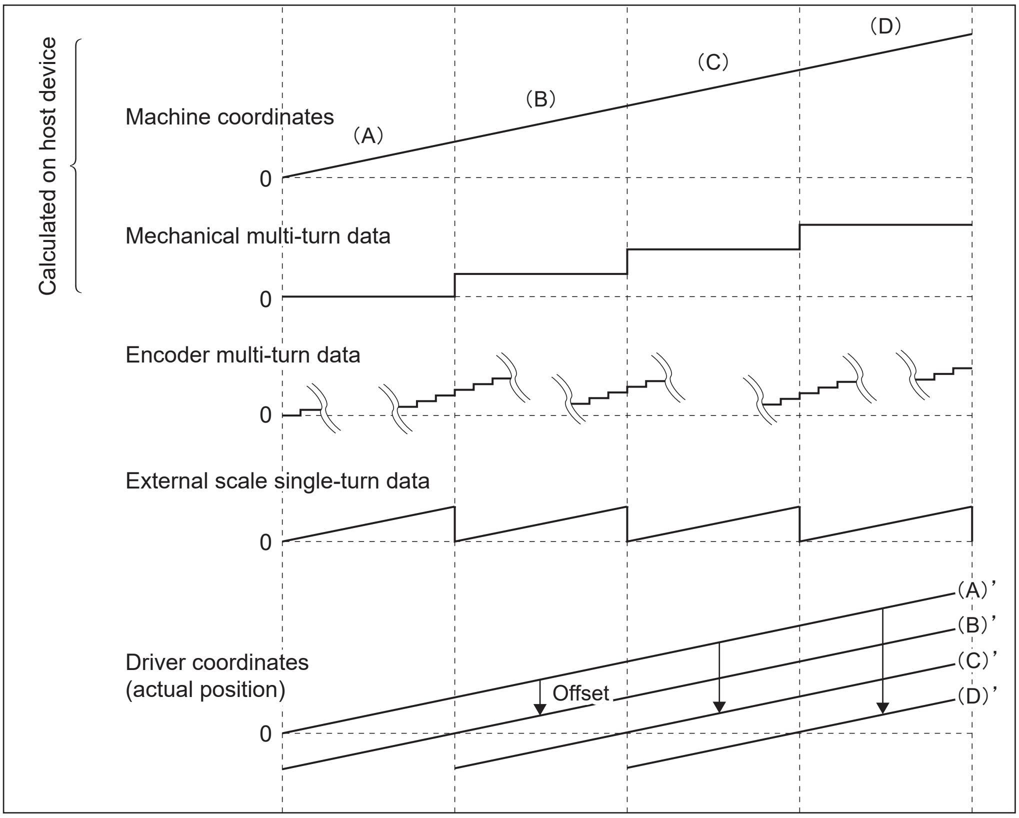
Driver coordinates refers to the actual position (position that can be acquired using Obj.6064h:00h “Position actual value” ). When setting the command position from the host, input values according to the driver coordinates.

The range within which driver coordinate data can be acquired is the signed 32-bit range (-2147483648 to 2147483648). If the maximum value is exceeded, the value will wrap around.

**— Precautions —**

- Because the driver coordinates are initialized based on the “external scale single-turn data” present when the power supply is switched on, depending on the machine coordinates when powered on, the driver coordinates and machine coordinates may not line up.
- In the figure shown below for control-related position data, if powered on within the range of machine coordinates (A), the driver coordinates become (A)’. If turned on within the (B) range, then they become (B)’.

  If the machine coordinates and driver coordinates do not match, the operation may not be performed correctly if the target position is set as the command position based on the machine coordinates standard and position control is performed. In this case, a value must be set that takes into account the amount of deviation (offset) between the machine coordinates and driver coordinates as the command position.



- How to use

After setting the following parameters as appropriate, write to EEPROM and switch the power supply back on.

1 Pr0.01 “Control mode setup”

Set to set value 6 (full-closed control).

2 Pr0.15 “Absolute encoder setup”

Set to set value 0 (for use with absolute system).

3 Pr3.23 “External scale selection”

Set to set value 6 (serial communication type (absolute rotary specification)).

4 Pr9.01 “Feedback scale resolution”

Set to the feedback scale resolution value that is to be used.

5 Pr3.24 “Numerator of external scale division” , Pr3.25 “Denominator of external scale division”

Set the dividing ratio of the encoder resolution and feedback scale resolution.

(Example 1) With 23 bit absolute encoder and 23 bit absolute rotary scale, Pr3.24 “Numerator of external scale division” = 1 and Pr3.25 “Denominator of external scale division” = 1

(Example 2) With 23 bit absolute encoder and 27 bit absolute rotary scale, Pr3.24 “Numerator of external scale division” = 1 and Pr3.25 “Denominator of external scale division” = 16

For details, see *“7.6.4 External Scale Dividing Ratio Settings”* .

6 Pr3.26 “Reversal of direction of external scale”

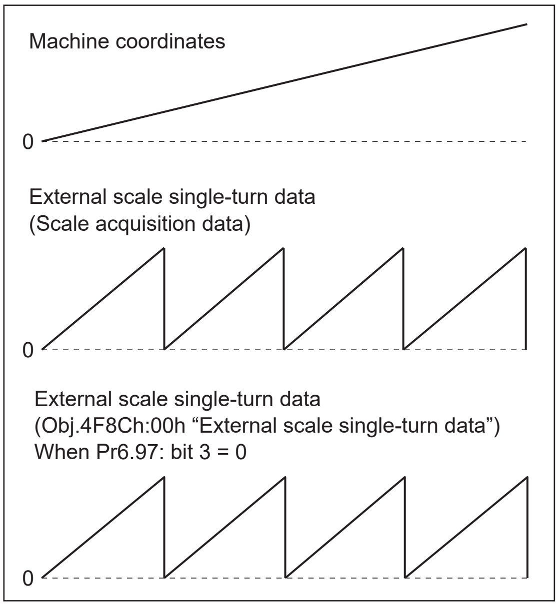
If the scale position data when the motor axis is rotated in the counterclockwise (CCW) direction is counted-up, use set value 0.

If the installation conditions or some other factor mean that it is not possible to install the external scale in the aforementioned direction, use set value 1.

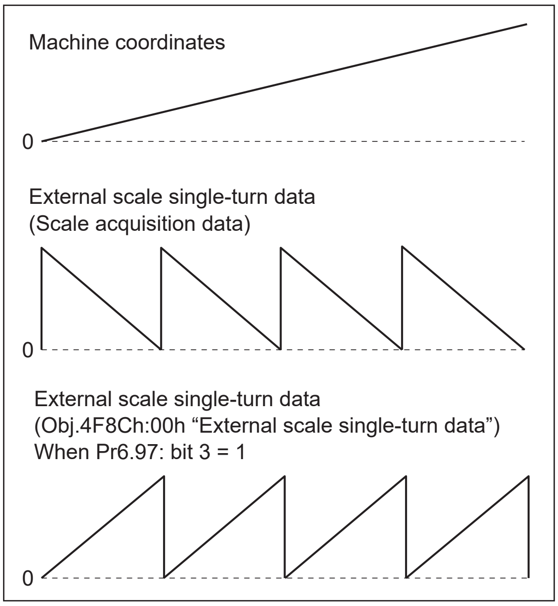
7 Pr6.97:bit 3 “Selection of external scale single-turn data monitor”

The monitor specification for external scale single-turn data can be changed.

■ Axis for which a setting of Pr3.26 = 0 is required



■ Axis for which a setting of Pr3.26 = 1 is required



8 Obj.4F8Ch:00h “External scale single-turn data”

Allows external scale single-turn data to be acquired, which, when combined with the encoder multi-turn data, can be used to calculate the machine coordinates.

For details, see Technical Reference Communication Specification.

## ■ Precautions

1 When calculating machine coordinates, check that the external scale single-turn data is positioned near the median. If calculating when the external scale single-turn data is positioned close to the 0 position, you may end up receiving inadequate encoder multi-turn data due to mechanical torsion, and it may not be possible to calculate the correct machine coordinates.

2 Although the driver coordinate sign inverts when Pr3.26 “Reversal of direction of external scale” is set to 1, keep in mind that the encoder multi-turn data sign and external scale single-turn data sign do not invert.

3 Note that as the maximum value for the encoder multi-turn data is $2^{16}$ - 1 = 65535, the maximum value for the mechanical multi-turn data is 65535/reduction ratio.

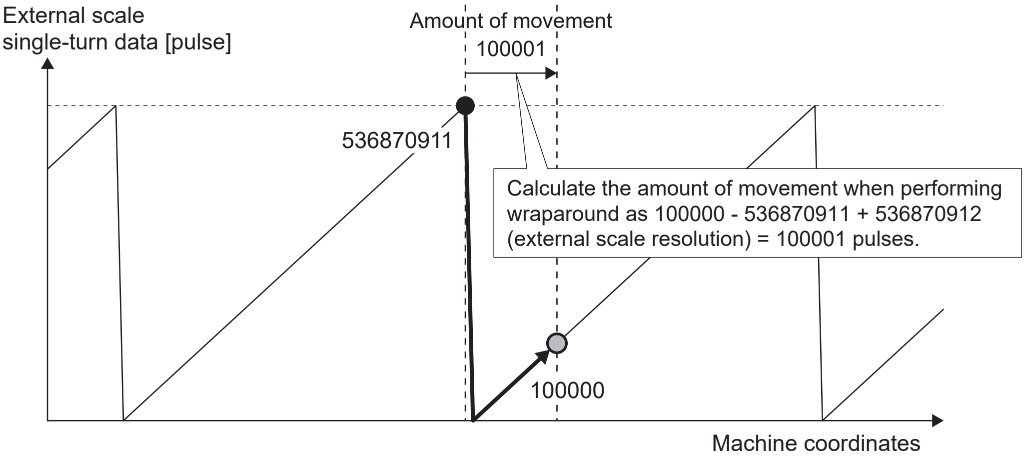
4 External scale single-turn data is wrapped around if it passes the maximum value or the 0 position.

Therefore, when calculating the movement amount in the machine coordinates using the difference between the current value previous value for the external scale single-turn data, add (or subtract) the feedback scale resolution when performing wraparound in order to calculate the correct movement amount.

If wrapping around in the count-up direction using a 29-bit external scale (536870912 resolution) and the previous value is 536870911 pulses and the current value is 100000 pulses, the movement amount is 100001 pulses (see figure below).

### Example of wraparound

If external scale single-turn data is changed from 536870911 pulses to 100000 pulses



Calculate the amount of movement when performing wraparound as 100000 - 536870911 + 536870912 (external scale resolution) = 100001 pulses.

5 Use an electronic gear ratio of 1/1.

One command pulse (one command unit) when using an electronic gear ratio of 1/1 is one pulse for the external scale.

In full-closed control, velocity control is performed by encoder feedback, and position control is performed by external scale feedback.

For details, see *“6.6.8 Motion Common Functions”* .

6 Set Pr3.28 “Hybrid deviation excess setup” and Pr3.29 “Hybrid deviation clear setup” to appropriate values. If the hybrid deviation excess range is too large, detection of errors is delayed, making it ineffective. On the other hand, if the hybrid deviation excess range is too small, the amount of motor or machine torsion generated during normal operation may be detected as an error.

For details, see *“7.6.5 Hybrid Deviation Excess Setup”* .

7 Increasing the external scale ratio may increase operating noise.

8 Using an incorrect external scale dividing ratio may trigger Err25.0.0 “Hybrid deviation excess protection” , especially when using a long stroke distance, even if the external scale and motor position are matched. In such cases, adjust the external scale dividing ratio to a value as close as possible and widen the excessive hybrid deviation range.

9 If using full-closed controls (rotary scale), the absolute encoder must be connected.

# 8 Application

## 8.1 Torque Limit Switching Function

This function changes the torque limit value according to the operation direction.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, torque control, and full-closed control |
| Other | ● Must be in servo-on state.<br>● Elements other than servo parameters are appropriately set, enabling the motor to rotate normally. |

### ■ Setup value

—: None

<table>
<tr><th>Class</th><th>No.</th><th>Attribute (*1)</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>13</td><td>B</td><td>1st torque limit</td><td>0 to 500</td><td>%</td><td>Sets the 1st torque limit for the torque output by the motor.</td></tr>
<tr><td>5</td><td>11</td><td>B</td><td>Torque setup for emergency stop</td><td>0 to 500</td><td>%</td><td>Sets the torque limit for emergency stop.<br>The normal torque limit is used when this setup value is 0.</td></tr>
<tr><td>5</td><td>21</td><td>B</td><td>Selection of torque limit</td><td>0 to 5</td><td>—</td><td>Sets the torque limit selection method.</td></tr>
<tr><td colspan="7">
<table>
<tr><th>Setup value</th><th>Negative direction</th><th>Positive direction</th></tr>
<tr><td>0</td><td colspan="2">Internally set to 1</td></tr>
<tr><td>1</td><td colspan="2">Pr0.13</td></tr>
<tr><td>2</td><td>Pr5.22</td><td>Pr0.13</td></tr>
<tr><td>3</td><td colspan="2">Pr0.13</td></tr>
<tr><td>4</td><td>Pr5.22</td><td>Pr0.13</td></tr>
<tr><td>5</td><td>60E1h</td><td>60E0h</td></tr>
</table>
● For torque control, the setting is valid for Pr5.21 = 5 only.<br>If Pr5.21 = 1 to 4, Pr0.13 “1st torque limit” is applied to the torque limit.
</td></tr>
<tr><td>5</td><td>22</td><td>B</td><td>2nd torque limit</td><td>0 to 500</td><td>%</td><td>Sets the 2nd torque limit for the torque output by the motor.</td></tr>
</table>

*1 For attributes, see *“6.2 Object Dictionary List”* .

*2 Torque limit setting ranges and factory default settings vary between different combinations of servo drivers and motors. For details, see *“Torque limit setup range”* in *“Operation”* .

### ■ Related objects

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Units</th><th>Range</th><th>Data Type</th><th>Access</th><th>PDO</th><th>Op-mode</th><th>EEPROM</th></tr>
<tr><td>6072h</td><td>00h</td><td>Max torque</td><td>0.1%</td><td>0 to 65535</td><td>U16</td><td>rw</td><td>Yes</td><td>ALL</td><td>Yes</td></tr>
<tr><td colspan="10">● Sets the maximum motor torque.<br>● The maximum value of this object is limited to the maximum torque output by the motor using internal processing.<br>● The maximum motor torque may vary depending on the motor used.</td></tr>
</table>

Limit the torque command to the minimum value of the enabled limit value of Pr0.13 “1st torque limit” or Pr5.22 “2nd torque limit” and the Obj.6072h:00h “Max torque” limit value.

## ■ Operation

### Torque limit setup range

The torque limit setup range is 0 to 300 and the factory default value is 300, except for the motor and servo driver combinations listed in the table below.

For initial values, see *“6.2 Object Dictionary List”* .

Pr0.13 “1st torque limit” , Pr5.22 “2nd torque limit” , and Pr5.11 “Torque setup for emergency stop” are subject to the torque limit values in the table below.

Changing the motor model may change the torque limit values in the table below, so please reconfirm and reconfigure the parameter setup values to be limited.

| Size | Driver part no. | Applicable motors | Torque limit value |
|---|---|---|---|
| A | MADN061B☐ | MHMG5AZU☐1☐☐☐ | 350 |
|  | MADN081B☐ | MHMG011U☐1☐☐☐ | 350 |
|  | MADN065B☐ | MHMG5AZU☐1☐☐☐ | 350 |
|  |  | MHMG012U☐1☐☐☐ | 350 |
|  | MADN085B☐ | MHMG022U☐1☐☐☐ | 350 |
| B | MBDN121B☐ | MHMG021U☐1☐☐☐ | 350 |
|  | MBDN125B☐ | MHMG042U☐1☐☐☐ | 350 |
| C | MCDN201B☐ | MHMG041U☐1☐☐☐ | 350 |
|  | MCDN205B☐ | MHMG082U☐1☐☐☐ | 350 |
| D | MDDN405B☐ | MHMG092U☐1☐☐☐ | 350 |

## 8.2 Torque Saturation Protection Function

Triggers an alarm when torque saturation condition lasts for a set amount of time.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, and full-closed control |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 57 | B | Torque saturation error protection detection time | 0 to 5000 | ms | Sets torque saturation error protection detection time.<br>If torque saturation lasts for longer than the set time, Err16.1.0 “Torque saturation error protection” is triggered.<br>When this setup value is 0, the setup value for Pr7.16 “Torque saturation error protection frequency” is enabled. |
| 7 | 03 | A | Output setup during torque limit | 0 to 1 | — | Set up judgment condition of output while torque is limited by torque control.<br>0: On at torque limit including torque command value<br>1: On at torque limit excluding torque command value |
| 7 | 16 | B | Torque saturation error protection frequency | 0 to 30000 | Incidences | If torque saturation persists for the preset count, Err16.1.0 “Torque saturation error protection” is triggered.<br>The count increases by 1 every 0.25 ms. For example, when set to 30000, Err16.1.0 “Torque saturation error protection” is triggered if torque saturation persists for 7.5 seconds.<br>The count is cleared when the torque saturation condition is removed.<br>When the setup value for Pr6.57 “Torque saturation error protection detection time” is not 0, the setup value for Pr6.57 “Torque saturation error protection detection time” is enabled. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

Set both Pr6.57 “Torque saturation error protection detection time” and Pr7.16 “Torque saturation error protection frequency” to 0 to disable this function.

This function is disabled and Err16.1.0 “Torque saturation error protection” cannot be triggered during torque control.

This function is disabled and Err16.1.0 “Torque saturation error protection” cannot be triggered when the emergency stop alarm is triggered.

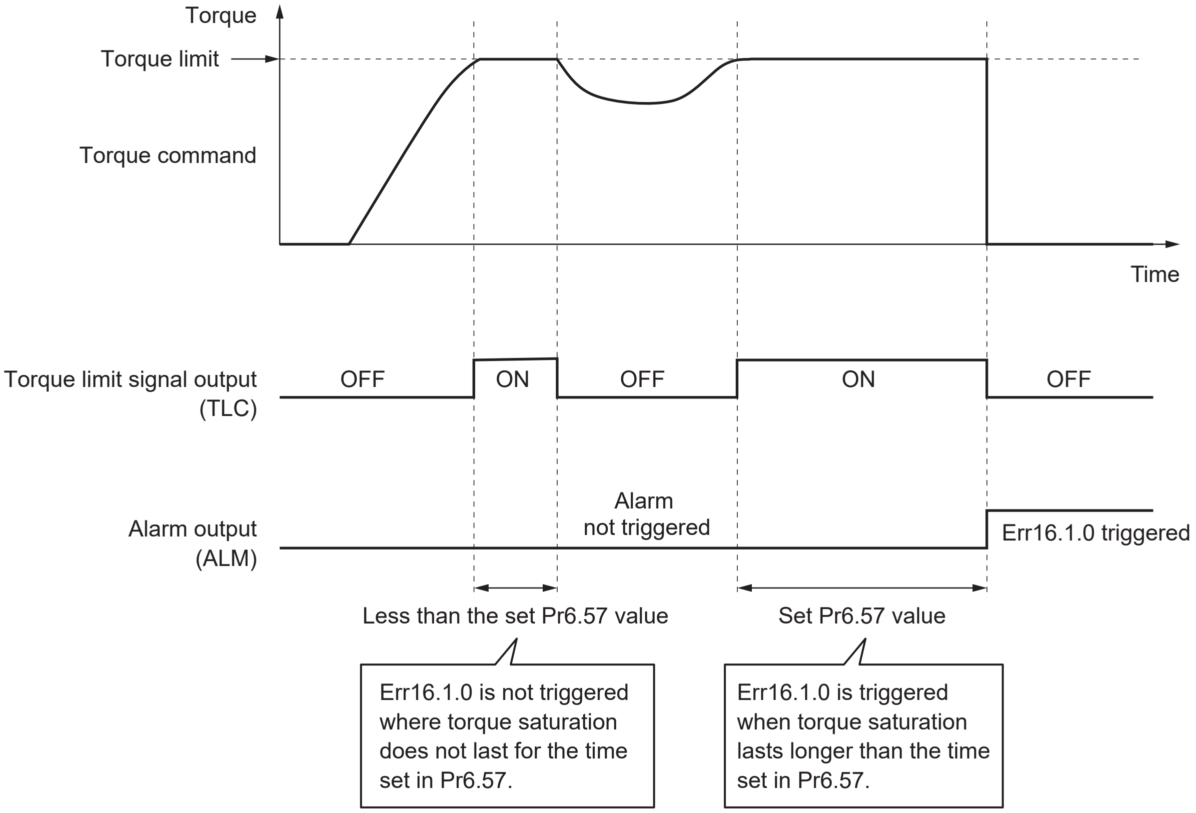
Torque saturation is determined using the currently enabled torque limit.

For details on torque limits, see *“8.1 Torque Limit Switching Function”* .

When this function is enabled, alarm detection is performed even when at servo-off.

## ■ Operation

**Example of when torque saturation protection does and does not activate**



## 8.3 Position Comparison Output Function

This function issues pulse signals from general-purpose outputs or encoder output terminals when the actual position passes the position set for the parameter.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |
| Other | ● Extended version 1 or later software version<br>● After establishing EtherCAT communication (ESM state is PreOP or higher).<br>● Homing operation has been completed.<br>Note that when Pr7.80:bit 6 = 1, the homing operation completion status is not completed when the control mode is switched to HM.<br>● Elements other than servo parameters are appropriately set, enabling the motor to rotate normally.<br>● Not in continuous rotating absolute encoder mode (Pr0.15 = 4). |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 44 | R | Position comparison output pulse width setting | 0 to 32767 | 0.1 ms | Sets the pulse width of the signal output during position comparison.<br>When this setup value is 0, no pulse is output. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 45 | R | Position comparison output polarity selection | 0 to 7 | — | Sets position comparison output (CMP-OUT) polarity for each output terminal.<br>bit 0: Polarity for SO1 (general-purpose output) or OCMP1 (encoder/position comparison output terminal)<br>bit 1: Polarity for SO2 (general-purpose output) or OCMP2 (encoder/position comparison output terminal)<br>bit 2: Polarity for SO3 (general-purpose output) or OCMP3 (encoder/position comparison output terminal)<br>bits 7 to 3: Not used (set each bit to 0)<br>**Notes**<br>● When general-purpose output terminals (SO1 to SO3) are used as position comparison outputs (CMP-OUT), assign position comparison output to Pr4.10 “SO1 output selection” , Pr4.11 “SO2 output selection” , and Pr4.12 “SO3 output selection” for all control modes.<br>*Position comparison output cannot be monitored using the Set-up Support Software (PANATERM ver.7) or EtherCAT communication.<br>● To use encoder output signals (OA, OB) as position comparison output (OCMP1 to 3), set Pr4.47 “Pulse output selection” to 1.<br>● For details, see *“3.2.5.5.1 Control Output Signal”* of *“When changing and using the output signal assignment”* .<br>Setup values for bits 2 to 0<br>0: The output photocoupler is turned ON for SO1, SO2, and SO3 and OCMP1, OCMP2 and OCMP3 are set to L level during pulse output.<br>1: The output photocoupler is turned OFF for SO1, SO2, and SO3 and OCMP1, OCMP2 and OCMP3 are set to H level during pulse output.<br>**Notes**<br>● bits 2 to 0 should generally be set to 0. |
| 4 | 47 | R | Pulse output selection | 0 to 1 | — | Selects the signal output from the encoder output signal/position comparison output signal terminals (OA/OCMP1, OB/OCMP2, OCMP3).<br>0: Encoder output signal (use as OA, OB)<br>1: Position comparison output signal (use as OCMP1 through OCMP3) |
| 4 | 48 | A | Position comparison value 1 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 1. |
| 4 | 49 | A | Position comparison value 2 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 2. |
| 4 | 50 | A | Position comparison value 3 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 3. |
| 4 | 51 | A | Position comparison value 4 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 4. |
| 4 | 52 | A | Position comparison value 5 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 5. |
| 4 | 53 | A | Position comparison value 6 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 6. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 54 | A | Position comparison value 7 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 7. |
| 4 | 55 | A | Position comparison value 8 | -2147483648 to 2147483647 | Command unit | Sets comparison value for position comparison 8. |
| 4 | 56 | R | Position comparison output delay compensation amount | -32768 to 32767 | 0.1 μs | Corrects position comparison output delay caused by the circuit. |
| 4 | 57 | R | Position comparison output assignment setting | -2147483648 to 2147483647 | — | Sets the terminal(s) to output position comparison 1 to 8.<br>bit 3 to 0: Position comparison 1<br>bit 7 to 4: Position comparison 2<br>bit 11 to 8: Position comparison 3<br>bit 15 to 12: Position comparison 4<br>bit 19 to 16: Position comparison 5<br>bit 23 to 20: Position comparison 6<br>bit 27 to 24: Position comparison 7<br>bit 31 to 28: Position comparison 8<br>Setup values for each setting bit<br>Setup value<br>0 (0000b): Output disabled<br>1 (0001b): Output from SO1/OCMP1 terminal<br>2 (0010b): Output from SO2/OCMP2 terminal<br>3 (0011b): Output from SO3/OCMP3 terminal<br>Other than the above: Manufacturer use (setting is prohibited)<br>Multiple position comparison values can be set for one output terminal.<br>For example, setting parameters bits 3 to 0 = 1, bits 7 to 4 = 1 the SO1/OCMP1 terminal can output Position Comparison 1 and Position Comparison 2. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

**— Precautions —**

- If the same location information is set in Pr4.48 through Pr4.55 and Pr4.57 is set to output from multiple output terminals, a time lag may occur in the output signal.
- Example of setting the same values for position comparison value 1 and 2 and assigning different output pins to the position comparison output assignment settings

  <Position comparison value>

  Pr4.48: 1000000, Pr4.49: 1000000

  <Position comparison output assignment setting>

  Pr4.57: 00000021h (SO1/OCMP1 : Pr4.48, SO2/OCMP2 : Pr4.49 is assigned)
- If the setting for Pr4.45 "Position comparison output polarity selection" is changed before or after Config is executed from the Set-up Support Software (PANATERM ver.7) , the first position compare output signal may not be output correctly after Config is executed. Be sure to reconnect the power supply if you have changed Pr4.45 "Position comparison output polarity selection" .

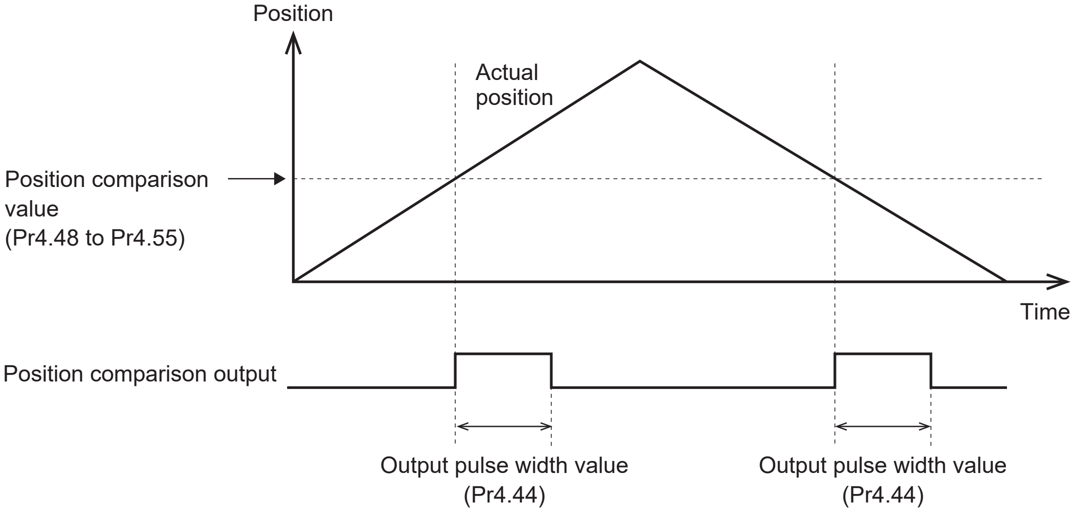
## ■ Operation

- Signal specifications

| | | |
|---|---|---|
| Trigger output | I/F | 3-Outputs: Photocoupler (open collector)<br>or<br>3-Outputs: Line driver |
| | Logic | Parameter settings (polarity can be set for each output) |
| | Pulse width | Parameter setup<br>0.1 to 3276.7 ms (unit: 0.1 ms) |
| | Delay correction | Supported |
| Compare source | Encoder (communication) | Supported |
| | External scale (communication) | Supported |
| | External scale (A/B-phase) | Supported |
| Position comparison value | Comparision number | 8 points |
| | Setting range | Signed 32 bit |

- Output example
  - When the actual position of the encoder passes the position comparison value (Pr4.48 to Pr4.55)

    Outputs a pulse of the duration set in Pr4.44 “Position comparison output pulse width setting” .

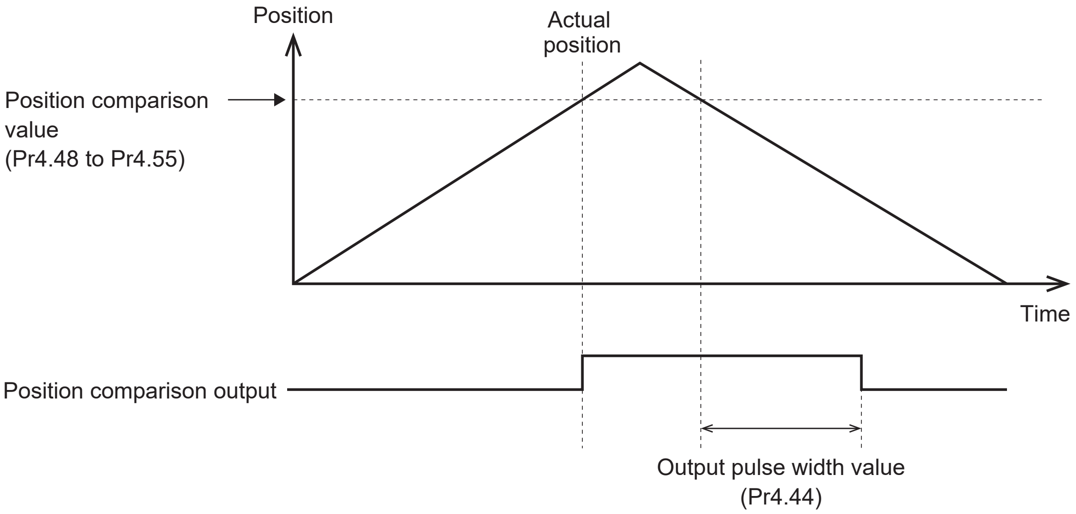


Regardless of the direction in which the encoder position is passed, a pulse is output when the magnitude relationship changes as it passes the position comparison value.

Multiple position comparison values can be set to one position comparison output.

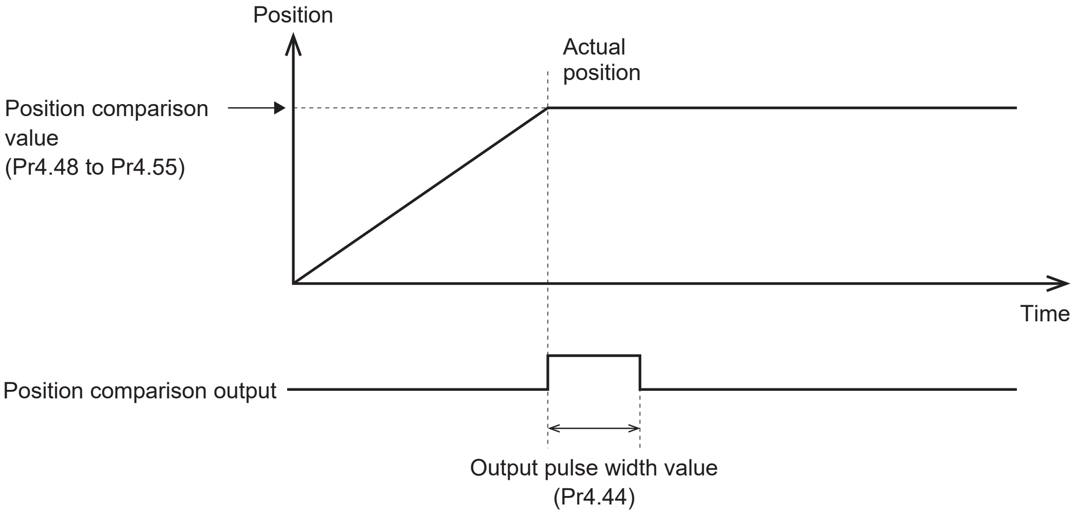
  - When the actual position of the encoder passes the position comparison value (Pr4.48 to Pr4.55) during position comparison pulse output

    If the encoder position or external scale position passes the position comparison value during pulse output when the operation direction has been reversed or when multiple position comparison values have been set, the pulse output will continue to be ON from the time of the most recent passing for the duration set in the output pulse width settings.



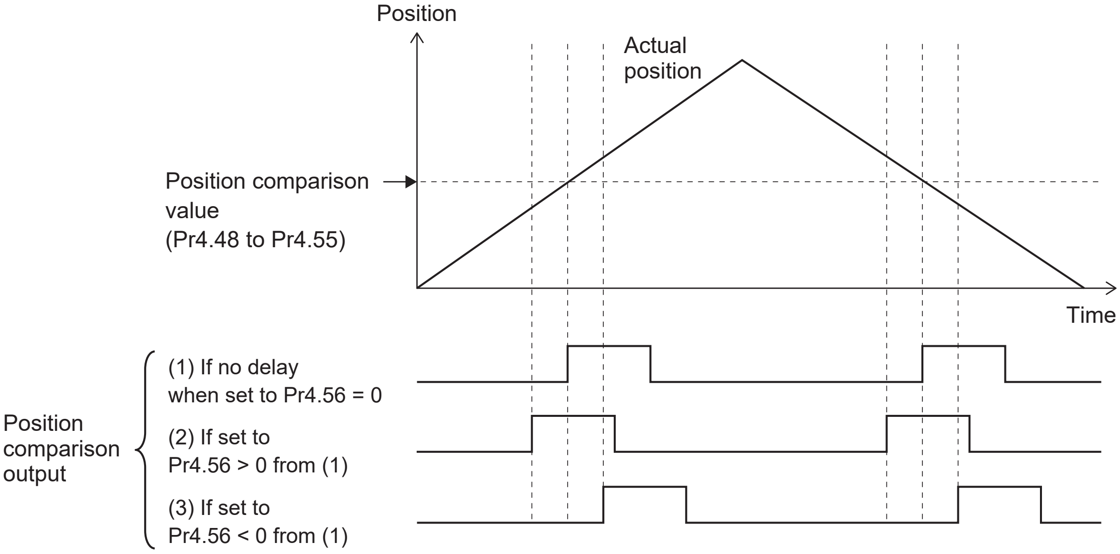
- If the actual position of the encoder is stopped at the same position as the position comparison value (Pr4.48 to Pr4.55)

  A pulse is output once, similarly to when a pass occurs.



- If the position comparison pulse output is automatically corrected before being output

  The position comparison output function sends outputs while automatically compensating, based on the previous motor speed, the errors caused by the delay time of encoder serial communication, etc. The amount of compensation can be tuned by setting the Pr4.56 “Position comparison output delay compensation amount” . For example, if the position comparison output function is used as an operating trigger for a camera or other external device, this can be set taking into account the delay time from when the external device receives the signal from the position comparison output until it operates.



## ■ Precautions

The following conditions may reduce the accuracy of the position comparison output:

- When the number of external scale pulses per motor revolution is extremely low compared to 23 bits with full-closed control.

## 8.4 Single-turn Absolute Function

This function uses the absolute encoder as an absolute system only for single-turn absolute position data without connecting the battery power.

The movable range of the motor is limited by single-turn data of the absolute encoder.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, torque control |
| Other | ● An absolute encoder is connected. |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 15 | C | Absolute encoder setup | 0 to 4 | — | Sets the method of use of the absolute encoder.<br>During full-closed control, the absolute encoder is treated as an incremental system (setting = 1) by the internal control.<br>0: Use as an absolute system (absolute mode).<br>1: Use as an incremental system (incremental mode) (Detection of the following protection functions is disabled.).<br>Err40.0.0 “Absolute system down error protection”<br>Err41.0.0 “Absolute counter over error protection”<br>Err42.0.0 “Absolute overspeed error protection”<br>Err45.0.0 “Multi-turn counter error protection”<br>2: Use as an absolute system (absolute mode), but ignore multi-turn counter overs.<br>3: Use as an absolute system (absolute mode), but do not use the multi-turn counter (Single-turn absolute mode).<br>4: Use as absolute system (absolute mode), but any value can be set for the upper-limit value of the multi-turn counter. Ignore multi-turn counter overs (Continuous rotating absolute encoder mode). |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Related objects

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | YES |
| | | ● After completing the execution of homing position control mode (hm), the position information is set so that the detected Index pulse position functions as the value for this object.<br>● It will be added to the positional information when the position information below is initialized (preset).<br>• When control power is turned on<br>• When communication is established (when ESM status transitions from Init -> PreOP)<br>• When clearing multi-turn data<br>• When operations (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) are completed using the Set-up Support Software (PANATERM ver.7)<br>• When Config is executing from Set-up Support Software (PANATERM ver.7) | | | | | | | |

## ■ How to use

- Enabling the single-turn absolute function

  This function is enabled by setting Pr0.15 “Absolute encoder setup” to 3.

  When this function is enabled, absolute encoder multi-turn data is not used. Alarms (Err40.0.0 “Absolute system down error protection” , Err41.0.0 “Absolute counter over error protection” , Err42.0.0 “Absolute overspeed error protection” , Err45.0.0 “Multi-turn counter error protection” ) and battery warnings for multi-turn data are not detected.

- Command position input range

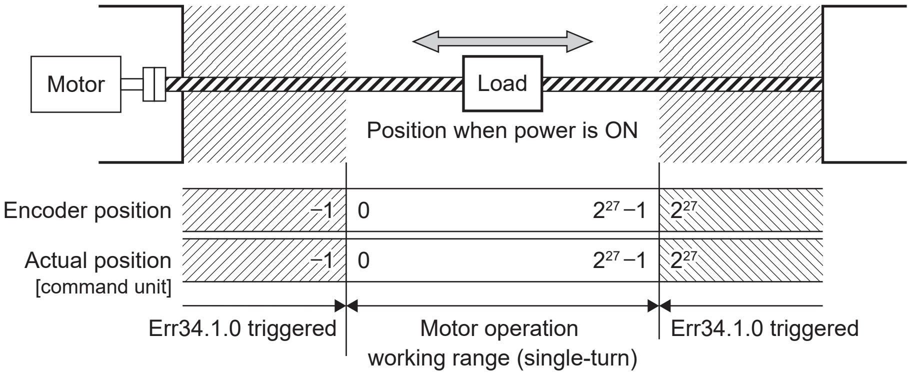
  When this function is enabled, the command position input range for EtherCAT communication is as in the table below.

| | Electronic gear ratio | Obj.607Ch:00h “Home offset” | Position command input range |
|---|---|---|---|
| Absolute encoder (27 bit) | 1/1 | 0 | 0 to $2^{27}$-1 (134217727) |
| | 1/1 | 10000 | 10000 to $2^{27}$-1 + 10000 (134227727) |

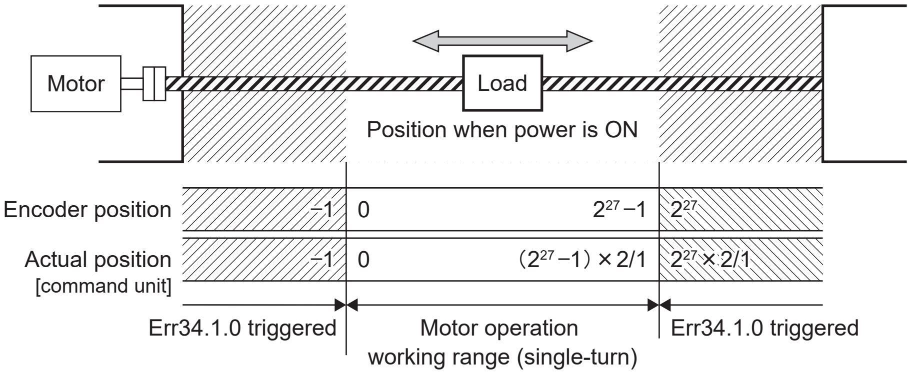
- Single-turn effective range

  When using an absolute encoder, the effective range of a single turn is as follows.

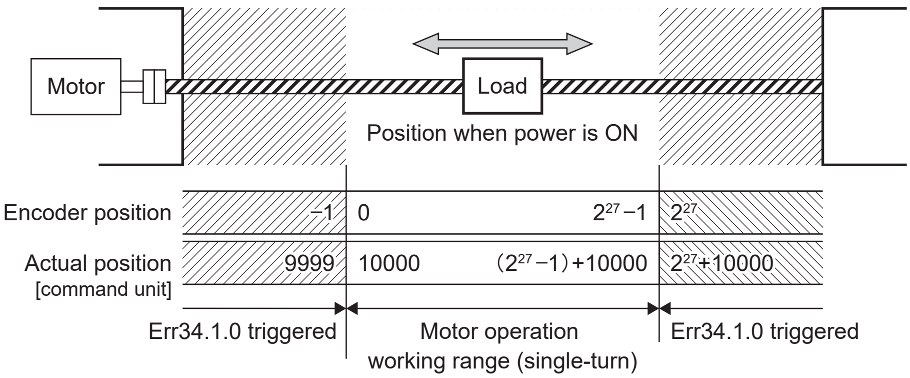
  - CCW = positive direction, electronic gear ratio = 1/1, Obj.607Ch:00h “Home offset” = 0



  - CCW = positive direction, electronic gear ratio = 1/2, Obj.607Ch:00h “Home offset” = 0



- CCW = positive direction, electronic gear ratio = 1/1, Obj.607Ch:00h “Home offset” = 10000



If the motor (encoder) position exceeds the motor movable range (single-turn data of the encoder), Err34.1.0 “Single-turn absolute movable range error protection” is triggered.

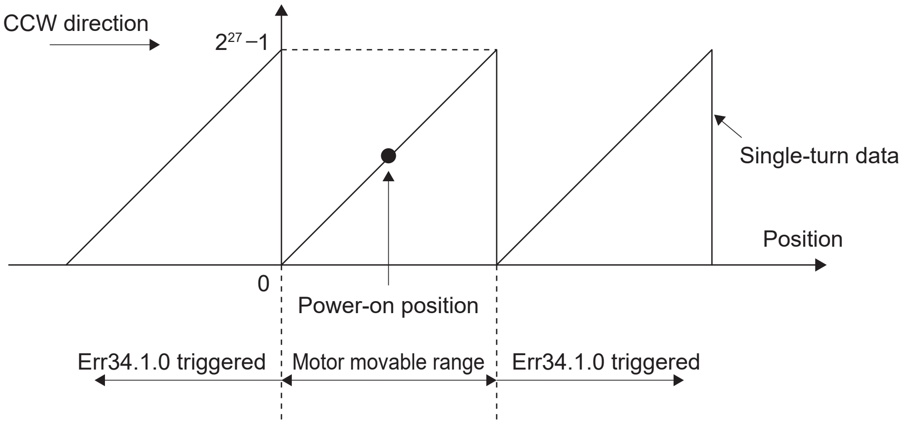
When Err34.1.0 “Single-turn absolute movable range error protection” is triggered, deceleration to stop is performed according to Pr5.10 “Sequence at alarm” .

- Motor position when switching the power on

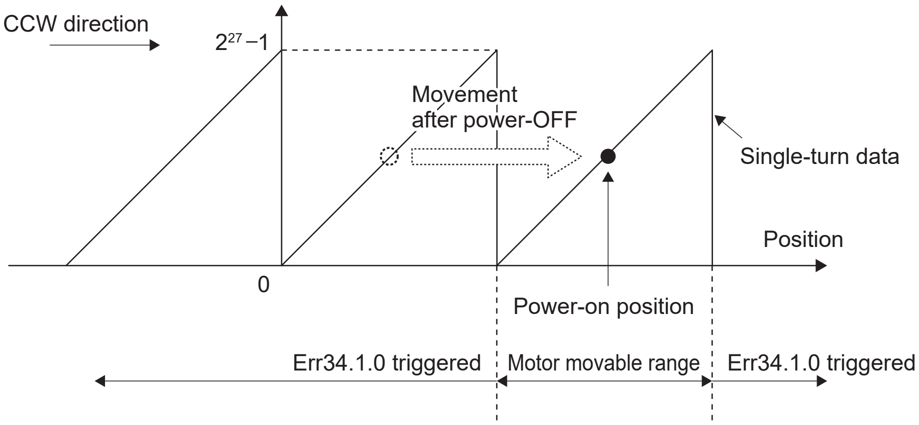
The motor working range is determined by the motor position upon power on.

The following shows examples of operations with an absolute encoder.

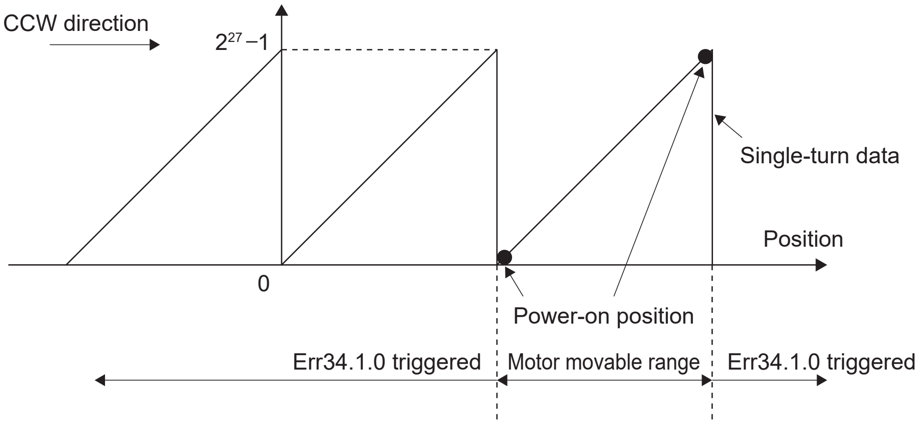
- When the power is turned on with the motor in the position shown in the figure below, the movable range of the motor is the single-turn data range from the position when powered on.



- When the power is turned off at the power-on position in the figure above and then turned on again after the motor is moved to the position in the figure below, the movable range of the motor changes.



- Note that if powered on in a position that is near the limit of the motor movable range, the movable range of the motor will be exceeded when the motor operates, even if only slightly, causing Err34.1.0 “Single-turn absolute movable range error protection” to be triggered.

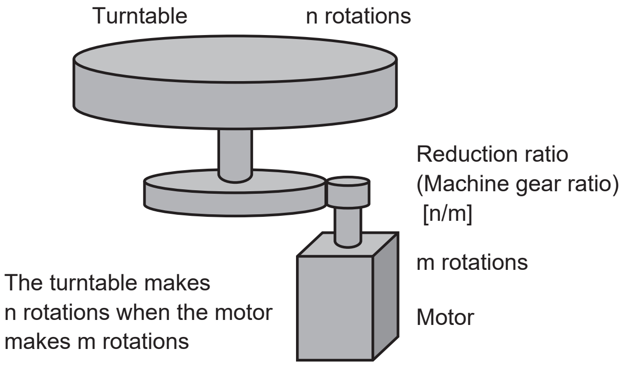


## 8.5 Continuous Rotating Absolute Encoder Function

This function sets any upper-limit value for absolute encoder multi-turn data.

With this function, it is possible to determine the turn angle (position) of a turntable and such other applications, even in the case of continuous rotation in one direction.

For the structure of the absolute system, see *"7.2.7 Absolute Encoder"* .



### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | • Position control, velocity control, torque control |
| Other | • Requires a 27-bit resolution absolute encoder.<br>• The value for "command position per single-turn of the turntable = Encoder resolution ($2^{27}$)/Electronic gear ratio/Reduction ratio [n/m]" must be an integer of $2^{31}$ or lower.<br>• Elements other than servo parameters are appropriately set, enabling the motor to rotate normally. |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 15 | C | Absolute encoder setup | 0 to 4 | — | Sets the method of use of the absolute encoder.<br>During full-closed control, the absolute encoder is treated as an incremental system (setting = 1) by the internal control.<br>0: Use as an absolute system (absolute mode).<br>1: Use as an incremental system (incremental mode) (Detection of the following protection functions is disabled.).<br>Err40.0.0 "Absolute system down error protection"<br>Err41.0.0 "Absolute counter over error protection"<br>Err42.0.0 "Absolute overspeed error protection"<br>Err45.0.0 "Multi-turn counter error protection"<br>2: Use as an absolute system (absolute mode), but ignore multi-turn counter overs.<br>3: Use as an absolute system (absolute mode), but do not use the multi-turn counter (Single-turn absolute mode).<br>4: Use as absolute system (absolute mode), but any value can be set for the upper-limit value of the multi-turn counter. Ignore multi-turn counter overs (Continuous rotating absolute encoder mode). |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 88 | C | Absolute encoder multi-turn data upper-limit value | 0 to 65534 | — | Sets the absolute multi-turn data upper-limit value when set to continuous rotating absolute encoder mode (Pr0.15 = 4).<br>Multi-turn data will change to 0 if the multi-turn data exceeds this set value.<br>Conversely, it will change to this set value if it falls below 0.<br>● Set Pr6.88 “Absolute encoder multi-turn data upper-limit value” to (m-1). m indicates the deceleration ratio denominator.<br>● Set Pr6.88 “Absolute encoder multi-turn data upper-limit value” and the electronic gear ratio so that the actual position and command position do not exceed $2^{31}$.<br>If (((Pr6.88 + 1) × encoder resolution) × (electronic gear inverse conversion value) - 1) is $2^{31}$ or more, Err93.8.☐ “Parameter setup error protection 6” is triggered.<br>The actual position of this product is set by considering Obj.607Eh:00h “Polarity” , Obj.607Ch:00h “Home offset” , etc.<br>For details, see *“6.6.8.4.4 Initialization of Absolute Encoder (During Semi-closed Control)”* .<br>When set to absolute mode (Pr0.15 = 0 or 2), the absolute multi-turn data upper-limit value is 65535 regardless of the set value.<br>When set to incremental mode (Pr0.15 = 1) or single-turn absolute mode (Pr0.15 = 3), this setting is disabled. |
| 6 | 98 | R | Function expansion setup 4 | -2147483648 to 2147483647 | — | bit 3: Effective bit expansion for multi-turn data<br>0: Enabled (-32768 to 32767 rotations)<br>1: Disabled (-16 to 15 rotations) |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Related objects

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 607Ch | 00h | Home offset | Command unit | -2147483648 to 2147483647 | I32 | rw | RxPDO | ALL | Yes |

- After completing the execution of homing position control mode (hm), the position information is set so that the detected Index pulse position functions as the value for this object.
  - Set Obj.607Ch:00h “Home offset” within the range of 0 to (((Pr6.88 + 1) × encoder resolution) × (electronic gear inverse conversion value) - 1). If set outside this range, Err93.8.☐ “Parameter setup error protection 6” is triggered.
- It will be added to the positional information when the position information below is initialized (preset).
  - When control power is turned on
  - When communication is established (when ESM state transitions from Init → PreOP)
  - When clearing multi-turn data
  - When operation (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) is completed with Set-up Support Software (PANATERM ver.7)
  - When Config is executing from Set-up Support Software (PANATERM ver.7)

## ■ How to use

- Examples

The continuous rotating absolute encoder function is enabled by setting Pr0.15 “Absolute encoder setup” to 4 and switching back on the control power.

The procedure for usage under the conditions of a “reduction ratio of 50 motor rotations and 4 turntable rotations (m = 50, n = 4)” is given below as an example.

1 Set Pr0.15 “Absolute encoder setup” = 4,Pr6.88 “Absolute encoder multi-turn data upper-limit value” = 49 and write to EEPROM.

2 Turn the control power of the product back on (Or execute attribute C enable command.).

3 The upper-limit value of the multi-turn data on the encoder side is automatically updated when the product is started up.

4 Err92.3.□ “Multi-turn data upper limit value disagreement error protection” is triggered.

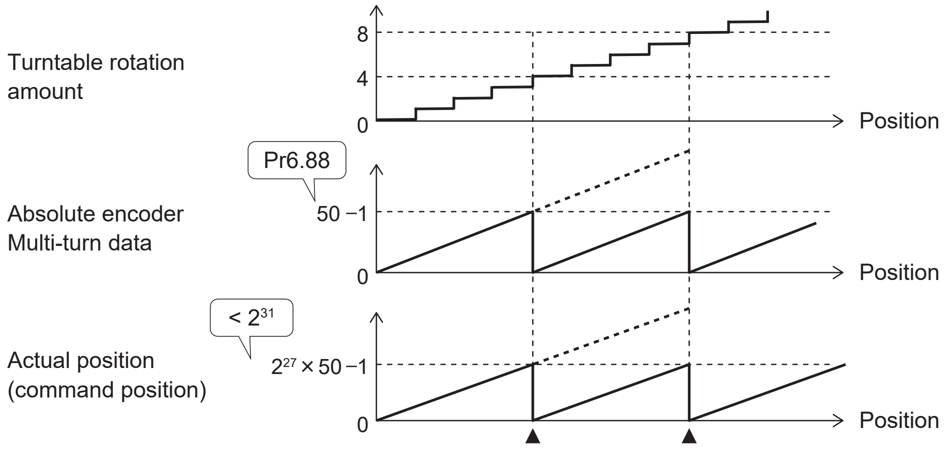
5 Turn the control power of the product back on.

6 The multi-turn data upper-limit value is enabled and the actual position is generated as shown in the figure below.

7 The host device reads the actual position, and the command position is initialized.

8 The actual position wraps around at $2^{27} \times 50\text{-}1$, the command position wraps around to match with the actual position, and the continuous rotating absolute encoder mode operates.

*Because battery power supply connected to the encoder retains the multi-turn data upper-limit value, follow the steps above from “6” when you turn on the control power of this product the next time it is operated, and for all subsequent operations.

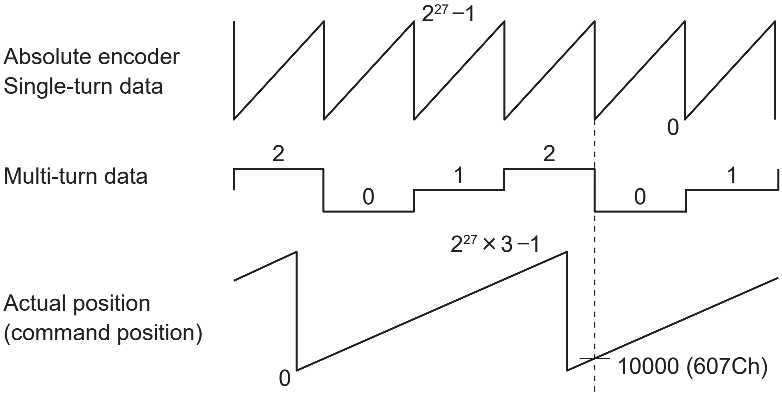


- Absolute home position offset

When the continuous rotating absolute encoder function is used, the absolute home position offset is as shown below.

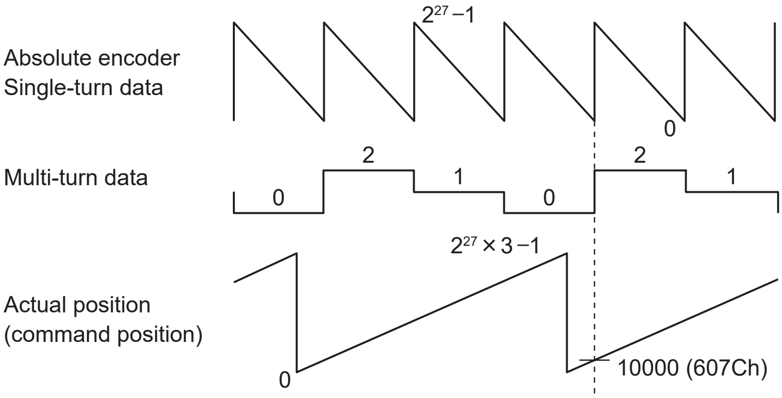
1 CCW = positive direction, electronic gear ratio = 1/1, Pr6.88 “Absolute encoder multi-turn data upper-limit value” =2

Obj.607Ch:00h “Home offset” = 10000



2 CW = positive direction, electronic gear ratio = 1/1, Pr6.88 "Absolute encoder multi-turn data upper-limit value" =2

Obj.607Ch:00h "Home offset" = 10000



## ■ Precautions

- If using this function with absolute positioning and profile position (pp) controls, or with cyclic position controls (csp), set a reachable position (a value that does not exceed the wraparound position within the Obj.607Bh: "Position range limit" range) as the target position.

  If an unreachable position is set as the target position, Err91.1.0 "Command error protection" is triggered.
- The actual position wraps around at the position at which the multi-turn data wraps around.

  Give a command position so that the position will match with this actual position.

  For details on wraparound processing, see *"6.6.8.4.5 Position range limit (607Bh)"* .
- When using this function for the first time or when Pr6.88 "Absolute encoder multi-turn data upper-limit value" has been changed to any value and the control power has been switched on again, Err92.3.☐ "Multi-turn data upper limit value disagreement error protection" will always be triggered, but there is no error.

  Once the control power of the product is powered on again, the above alarm will not occur the next time.

## 8.6 Pulse Regeneration Function

This function outputs the amount of movement of the actual position with the A/B-phase pulse.

It can communicate the amount of movement from this product to the host device.

It sets the output resolution, B-phase logic, and output source (encoder, external scale) when outputting signals with parameters.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, and full-closed control |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 11 | R | Number of output pulses per motor revolution | 1 to 33554432 | pulse | Sets the pulse output resolution as the output pulse counts per single-turn for OA and OB respectively. The pulse count of the controller by 4 multiplications is as follows.<br>Pulse output resolution per single-turn = Pr0.11 setup value × 4 |
| 0 | 12 | R | Reversal of pulse output logic | 0 to 3 | — | Sets the pulse output B-phase logic and output source. With this parameter, you can reverse the phase relationship between the A-phase pulse and the B-phase pulse by reversing the B-phase logic.<br>You can select either the encoder or external scale as the output source when the external scale position information monitoring function is active during semi-closed control, or during full-closed control. Select the encoder when not using full-closed control or when the external scale position information monitoring function is disabled in semi-closed control. |
| 4 | 47 | R | Pulse output selection | 0 to 1 | — | Selects signal output from pulse output / position comparison output terminal.<br>0: Encoder output signal<br>1: Position comparison output signal |
| 5 | 03 | R | Denominator of pulse output division | 0 to 134217728 | — | For applications where the number of output pulses per single turn is not an integer, this setup value can be set to a value other than 0 and the dividing ratio can be set by using Pr0.11 as numerator and Pr5.03 as denominator. Accordingly, the pulse count of the controller by 4 multiplications is as follows.<br>Pulse output resolution per single-turn<br>= (Pr0.11 value / Pr5.03 value) × encoder resolution |
| 5 | 33 | C | Pulse regenerative output limit setup | 0 to 1 | — | Enables or disables alarm detection (Err28.0.0 “Pulse regeneration limit protection” ).<br>0: Disabled<br>1: Enabled |
| 6 | 22 | R | AB phase external scale pulse outputting method selection | 0 to 1 | — | Select the pulse regeneration method of ABZ parallel external scale.<br>0: Directly output the AB-Phase signals from ABZ parallel external scale.<br>1: Output regenerated A/B-phase signals from ABZ parallel external scale. |

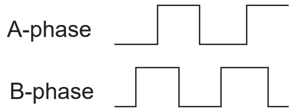
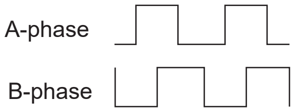
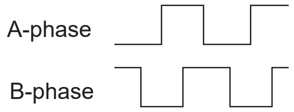
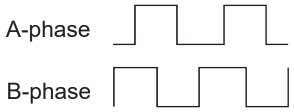
*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

Pulse regeneration output is as shown below by the combination of Pr0.11 “Number of output pulses per motor revolution” and Pr5.03 “Denominator of pulse output division” .

| Pr0.11 | Pr5.03 | Pulse regeneration output operation |
|---|---|---|
| 1 to 33554432 | 0 | **When the output source is the encoder**<br>Encoder pulse [pulse] $\xrightarrow{}$ $\boxed{\frac{\text{[Pr0.11 setting value]} \times 4}{\text{Encoder resolution}}}$ $\xrightarrow{}$ Output pulse [pulse]<br>* If Pr5.03 = 0, then the above process is performed based on the set value of Pr0.11. The number of pulses of pulse regeneration output OA and OB are the number of pulses set in Pr0.11. The output pulse resolution cannot be more than the encoder pulse resolution.<br>**When the output source is the external scale**<br>External scale pulse [pulse] $\xrightarrow{}$ $\boxed{\frac{1}{1}}$ $\xrightarrow{}$ Output pulse [pulse]<br>* When Pr5.03 = 0, the dividing ratio is 1:1. |
| 1 to 33554432 | 1 to 134217728 | Encoder FB pulse or external scale pulse [pulse] $\xrightarrow{}$ $\boxed{\frac{\text{[Pr0.11 setting value]}}{\text{[Pr5.03 setting value]}}}$ $\xrightarrow{}$ Output pulse [pulse]<br>* If Pr5.03 ≠ 0, the above process is performed based on set values of Pr0.11 and Pr5.03. This enables the system to support applications where the number of pulses per motor revolution is not an integer for pulse regeneration output OA and OB.<br>However, the output pulse resolution cannot be more than the encoder pulse resolution. |

The output pulse is as shown in the table below, depending on the setting of Pr0.12 “Reversal of pulse output logic” .

| Pr0.12 | B-phase logic | Output source | During CCW direction operation | During CW direction operation |
|---|---|---|---|---|
| 0 | Non-reversed | Encoder |  |  |
| 2 | | External scale | | |
| 1 | Reversed | Encoder |  |  |
| 3 | | External scale | | |

* Set values 2 and 3 are only enabled in any of the following conditions. If none of the following apply, please set the values to 0 and 1.

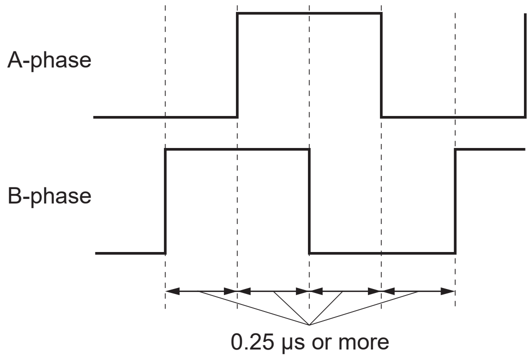
- When using full-closed control
- When external scale position information monitoring function is enabled under semi-closed control

## ■ Precautions

- The maximum frequency of pulse regeneration output is 4 Mpulse/s (after being multiplied by 4). The regenerative function may not work properly when moved at a velocity exceeding this and a correct pulse may not be returned to the host device, which may cause incorrect positioning depending on the method of use.

  Therefore, when using the pulse regeneration output function, enable Pr5.33 “Pulse regenerative output limit setup” and confirm in advance that Err28.0.0 “Pulse regeneration limit protection” is not detected in the device environment.

If Err28.0 is detected, tune the Pr0.11 “Number of output pulses per motor revolution” and Pr5.03 “Denominator of pulse output division” settings.



By enabling Pr5.33 “Pulse regenerative output limit setup” , Err28.0.0 “Pulse regeneration limit protection” can be generated upon reaching the pulse regeneration limit. Err28.0.0 “Pulse regeneration limit protection” is an alarm that is triggered when the pulse regeneration output limit is detected, and is not triggered at maximum output frequency.

The alarm may also be triggered if the frequency momentarily peaks due to motor rotation wobble.

- Z-phase signals do not correspond to pulse regeneration.

## 8.7 Sensor Feedback Function

### 8.7.1 Displacement Control Function

This function directly inputs the output signal of the displacement sensor to the servo driver to achieve a constant clearance for workpieces with varying heights, complete within the driver.

Settings for adjusting the position compensation value, filter settings for noise filtering, and offset adjustment can be performed. For details, see *“6.6.5.3.6 Displacement Control Function”* .

#### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control and full-closed control |

#### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 22 | R | Sensor feedback control mode setup | 0 to 1 | — | Selects the sensor feedback control mode for this product.<br>0: Sensor feedback disabled<br>1: Sensor feedback enabled (position feedback) |
| 3 | 33 | B | Analog input gain | 0 to 30000 | Command unit/mV | Converts the voltage applied to the analog input to a position compensation value in command units. |
| 3 | 34 | B | Analog input polarity | 0 to 1 | — | Selects the specification method for the positive direction and negative direction of displacement control.<br>0: Not reversed<br>1: Reversed |
| 3 | 35 | B | Analog input integration time constant | 0 to 100000 | 0.01 ms | Sets the integral time constant of the voltage applied to the analog input.<br>When this setup value is 0 or 100000, the integral time constant setting is disabled. |
| 3 | 36 | B | Analog input integration limit | 0 to 2147483647 | Command unit | Sets the limit for the integral term of the voltage applied to the analog input in absolute value. |
| 4 | 22 | B | Analog input (AIN) offset setting | -26666 to 26666 | 0.375 mV | Sets the offset adjustment value for the voltage applied to the analog input. |
| 4 | 23 | B | Analog input (AIN) filter setting | 0 to 6400 | 0.01 ms | Sets the time constant of the first order lag filter relative to the voltage applied to the analog input.<br>Disabled when the set value is 0 to 3. |
| 4 | 24 | B | Analog input (AIN) excessive setting | 0 to 100 | 0.1 V | Sets the excessive level for the applied voltage (after offset addition) of the analog input. If the absolute value of the applied voltage exceeds the setup value, Err39.0.0 “Analog input (AIN) excess protection” is triggered.<br>● Err39.0.0 trigger condition:<br>0 < Pr4.24 < Applied voltage (absolute value)<br>● Related control modes: All |

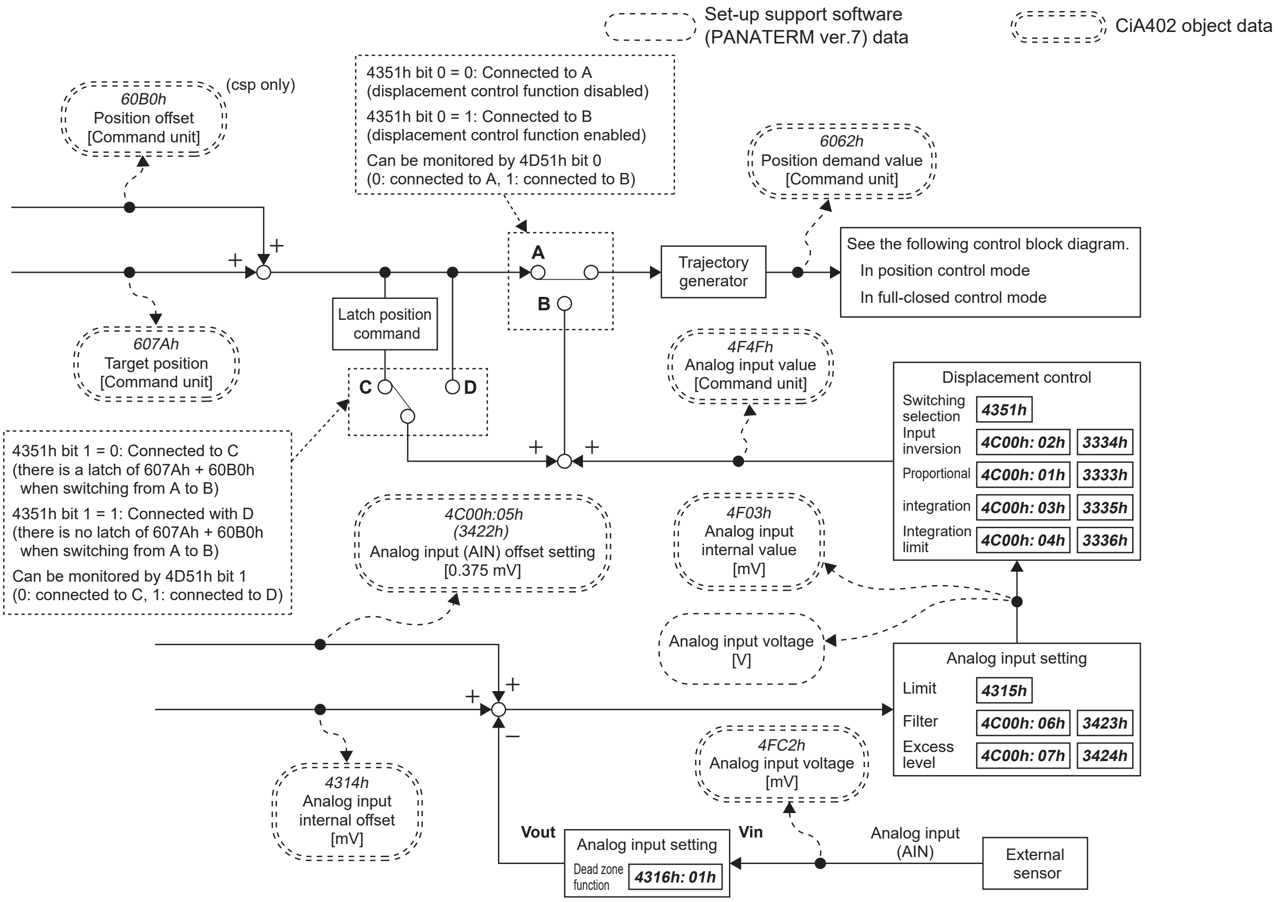
*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- Alarms related to the displacement control functions

| Alarm number | | | Name | Cause | Handling |
|---|---|---|---|---|---|
| Main | Sub | Primary cause | | | |
| 39 | 0 | 0 | Analog input (AIN) excess protection | A voltage higher than that set in Pr4.24 “Analog input (AIN) excessive setting” was applied to analog input. | ● Correctly configure Pr4.24 “Analog input (AIN) excessive setting” correctly.<br>● Check the connection status of the input/output connector.<br>● Set Pr4.24 to 0 and disable the protection function. |

## Control block diagram: Displacement control



*1 *"7.3.2 Position Control (Two-degree-of-freedom Control Mode Enabled)" "Control block diagram: Position control (when two-degree-of-freedom control mode is enabled) "*

*"7.3.3 Position Control (Two-degree-of-freedom Control Mode Disabled)" "Control block diagram: Position control (when two-degree-of-freedom control mode is disabled)"*

*2 *"7.6.2 Full-closed Control (Two-degree-of-freedom Control Mode Enabled)" "Control block diagram: Full-closed control (when two-degree-of-freedom control mode is enabled)"*

*"7.6.3 Full-closed Control (Two-degree-of-freedom Control Mode Disabled)" "Control block diagram: Full-closed control (when two-degree-of-freedom control mode is disabled)"*

* Numbers in italics (e.g., *607Ah*) represent EtherCAT object numbers.

* Numbers in bold (e.g., **1.00**) represent servo parameter numbers.

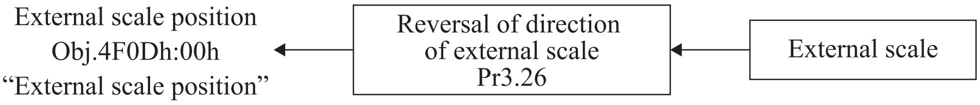
* Some objects such as polarity are omitted.

## 8.8 External Scale Position Information Monitor Function for Semi-closed Control

This function monitors external scale position information under semi-closed control using the EtherCAT object.

By monitoring the position information, the servo driver operates in semi-closed control mode, but the host device can control the servo driver as if it were in full-closed control mode.

This function allows monitoring of external scale position information in all semi-closed control modes (pp, csp, hm, pv, csv, tq, cst) and allows switching of control modes while controlling as in full-closed control.



### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, torque control |
| Other | ● Driver type must be one other than standard type. |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 3 | 23 | R | External scale selection | 0 to 2 | — | Select the type of external scale.<br>Ensure that the settings correspond to the type of external scale used.<br>0: A/B-phase output type<br>1: Serial communication type (incremental)<br>2: Serial communication type (absolute)<br>For details, see *“7.2.8 External Scale Selection Function”* . |
| 3 | 26 | R | Reversal of direction of external scale | 0 to 3 | — | Set the reversal of external scale feedback counter.<br>0: Not reversed<br>1: Reversed<br>2, 3: Manufacturer use (setting is prohibited)<br>For details, see *“7.2.8 External Scale Selection Function”* . |
| 3 | 27 | R | External scale Z phase disconnection detection disable | 0 to 1 | — | Enable/disable Z-phase disconnection detection when an A/B-phase output type external scale is used.<br>0: Enabled<br>1: Disabled |
| 7 | 22 | R | Communication function extended setup 1 | -32768 to 32767 | — | bit 4: External scale position information monitoring function setting for semi-closed control<br>0: Disabled<br>1: Enabled<br>**Notes**<br>● External scale position information can be monitored during full-closed control, regardless of the setting of this bit. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- Enabling this function enables the following functions for both full-closed control and semi-closed control. Note that the external scale alarm function is also enabled.
  - Readout function of the external scale position (Obj.4F0Dh:00h “External scale position” ) in EtherCAT communication
  - Readout function for the following external scale-related objects in EtherCAT communication
    - Obj.4D10h:01h “External scale vendor ID”
    - Obj.4D10h:02h “External scale model ID”
    - Obj.4F48h:00h “External scale pulse total”
    - Obj.4F49h:00h “External scale absolute position”
    - Obj.4F83h:00h “External scale communication error count (accumulated)”
    - Obj.4F84h:00h “External scale communication data error count (accumulated)”
    - Obj.4F87h:00h “External scale data (Higher)”
    - Obj.4F88h:00h “External scale data (Lower)”
    - Obj.4F89h:00h “External scale status”
  - External scale error detection function
    - Disconnection (Err93.3.□ “External scale connection error protection” Err50.0.0 “External scale wiring error protection” , Err55.0.0 “A-phase connection error protection” to Err55.2.0 “Z-phase connection error protection” )
    - Communication error (Err50.1.□ “External scale communication error protection” , Err50.2.0 “External scale communication data error protection” )
    - Status error (Err51.0.0 “External scale status error protection 0” to Err51.5.0 “External scale status error protection 5” )
    - Warning (WngA8h “External scale error warning” , WngA9h “External scale communication warning” )
- The external scale position (Obj.4F0Dh:00h “External scale position” ) in EtherCAT communication does not reflect the following.
  - Obj.607Eh:00h “Polarity”
  - Obj.608Fh: “Position encoder resolution” , Obj.6091h: “Gear ratio” , Obj.6092h: “Feed constant”
  - Obj.607Ch:00h “Home offset”

  Pr3.26 “Reversal of direction of external scale” will be reflected.
- External scale position (Obj.4F0Dh:00h “External scale position” ) is initialized when the following applies.
  - When control power is turned on

  No initialization is performed when homing.

## ■ Precautions

- Set Pr3.23 “External scale selection” to a value appropriate for the specifications of the external scale connected. Err93.3.□ “External scale connection error protection” triggers if the settings are inappropriate.

## 8.9 Deterioration Diagnosis Warning Function

This is a function to check the changes in motor and connected equipment characteristics to output deterioration diagnosis warnings.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 66 | A | Deterioration diagnosis convergence judgment time | 0 to 10000 | 0.1 s | Sets the time until real-time auto tuning load characteristic estimations are seen as converged when the deterioration diagnosis warning function is enabled (Pr6.97:bit 1 = 1).<br>When this set value is 0, it is set automatically inside the product in accordance with Pr6.31 “Real time auto tuning estimation speed” .<br>**Notes**<br>● When Pr6.31 “Real time auto tuning estimation speed” = 0, the deterioration diagnosis warning judgment for load characteristics estimated values (inertia ratio/friction characteristics) is disabled. |
| 5 | 67 | A | Deterioration diagnosis inertia ratio upper limit | 0 to 10000 | % | Sets the upper-limit values and lower-limit values for inertia ratio estimate in deterioration diagnosis judgment when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and load characteristics estimate convergence has been completed. |
| 5 | 68 | A | Deterioration diagnosis inertia ratio lower limit | 0 to 10000 | % | |
| 5 | 69 | A | Deterioration diagnosis unbalanced load upper limit | -1000 to 1000 | 0.1% | Sets the upper-limit values and lower-limit values for unbalanced load estimate in deterioration diagnosis judgment when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and load characteristics estimate convergence has been completed.<br>Set this setup value in 0.2 % increments. |
| 5 | 70 | A | Deterioration diagnosis unbalanced load lower limit | -1000 to 1000 | 0.1% | |
| 5 | 71 | A | Deterioration diagnosis dynamic friction upper limit | -1000 to 1000 | 0.1% | Sets the upper-limit values and lower-limit values for dynamic friction estimates in deterioration diagnosis judgment when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and load characteristics estimate convergence has been completed.<br>Set this setup value in 0.2 % increments. |
| 5 | 72 | A | Deterioration diagnosis dynamic friction lower limit | -1000 to 1000 | 0.1% | |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 73 | A | Deterioration diagnosis viscous friction upper limit | 0 to 10000 | 0.1 %/(10000 r/min) | Sets the upper-limit values and lower-limit values for viscous friction coefficient estimate in deterioration diagnosis judgment when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and load characteristics estimate convergence has been completed.<br>Set this setup value in 0.2 % increments. |
| 5 | 74 | A | Deterioration diagnosis viscous friction lower limit | 0 to 10000 | 0.1 %/(10000 r/min) | |
| 5 | 75 | A | Deterioration diagnosis velocity setting | -20000 to 20000 | r/min | Outputs deterioration diagnosis velocity output (V-DIAG) when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and the motor speed is within the range of Pr5.75 ± Pr4.35 (speed coincidence range).<br>Deterioration diagnosis velocity output (V-DIAG) has a hysteresis of 10 r/min. |
| 5 | 76 | A | Deterioration diagnosis torque average time | 0 to 10000 | ms | Sets the torque command average value calculation time (weighted count) when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and diagnosis velocity output (V-DIAG) is on.<br>The time from diagnosis velocity output (V-DIAG) on to the start judgment for the upper limit and lower limit of the torque command average value is also a part of the set time for this parameter.<br>If the setup value is 0, the torque command average value is not calculated. |
| 5 | 77 | A | Deterioration diagnosis torque upper limit | -1000 to 1000 | 0.1% | Sets the upper-limit values and lower-limit values of torque command average value when deterioration diagnosis warning is enabled (Pr6.97:bit 1 = 1) and deterioration diagnosis velocity output (V-DIAG) is on. |
| 5 | 78 | A | Deterioration diagnosis torque lower limit | -1000 to 1000 | 0.1% | |
| 6 | 97 | B | Function expansion setup 3 | -2147483648 to 2147483647 | — | Enables or disables the deterioration diagnosis warning function using bit 1.<br>0: Disabled<br>1: Enabled |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- Applicable range of deterioration diagnosis warning function
  - The deterioration diagnosis warning function for the below five types of data can be enabled by setting Pr6.97 “Function expansion setup 3” :bit 1 = 1.
    - Inertia ratio
    - Unbalanced load
    - Dynamic friction
    - Viscous friction coefficient
    - Torque command average value

  All types of deterioration diagnosis information can be confirmed using the EtherCAT communication servo information monitor object. For details, see *“6.6.8.7 Servo Information Monitoring Object”* .

- Deterioration diagnosis warning for load characteristic estimates (inertia ratio, unbalanced load, dynamic friction, viscous friction coefficient)
  - Deterioration diagnosis warning judgment for four load characteristic estimates (inertia ratio, unbalanced load, dynamic friction, and viscous friction coefficient) can be used when real-time auto tuning load characteristic estimation is enabled (See Operating Instructions (Tuning)).
  - The above-mentioned deterioration diagnosis warning judgment is enabled when the required operational conditions for load characteristic estimates has continued in total for Pr5.66 “Deterioration diagnosis convergence judgment time” or more, and the load characteristic estimates have converged.

    Once activated, the deterioration diagnosis warning judgment remains in effect until Pr6.97 “Function expansion setup 3” :bit 1 is set to 0 (disabled) or the real-time auto tuning load characteristic estimate expires.
  - As shown in the table below, the upper-limit values and lower-limit values for each load characteristic estimation value can be set in the parameter settings. If the load characteristic estimation value changes and upper-limit values or lower-limit values set by the parameters are exceeded, WngACh “Deterioration diagnosis warning” is generated.

    Note the following restrictions when setting upper-limit values and lower-limit values.
    - When the upper-limit value is set to the maximum value, the upper-limit judgment is disabled.
    - When the lower-limit value is set to the minimum value, the lower-limit judgment is disabled.
    - If upper-limit value ≤ lower-limit value, then both the upper-limit and lower-limit judgment are disabled.

| | Inertia ratio | Unbalanced load | Dynamic friction | Viscous friction |
|---|---|---|---|---|
| Upper-limit value | Pr5.67 | Pr5.69 | Pr5.71 | Pr5.73 |
| Lower-limit value | Pr5.68 | Pr5.70 | Pr5.72 | Pr5.74 |

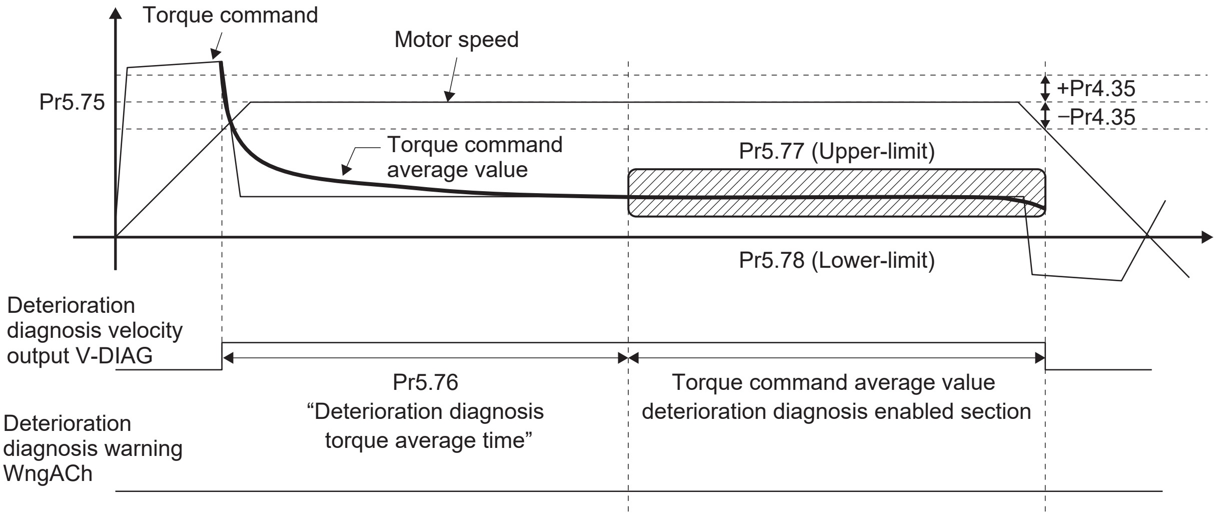
**Notes**

- If Pr6.31 “Real time auto tuning estimation speed” is set to 0 and estimation has been stopped from the start or before the load characteristic estimate results have been confirmed, deterioration diagnosis warning judgment is disabled even if real-time auto tuning load characteristic estimate is enabled.

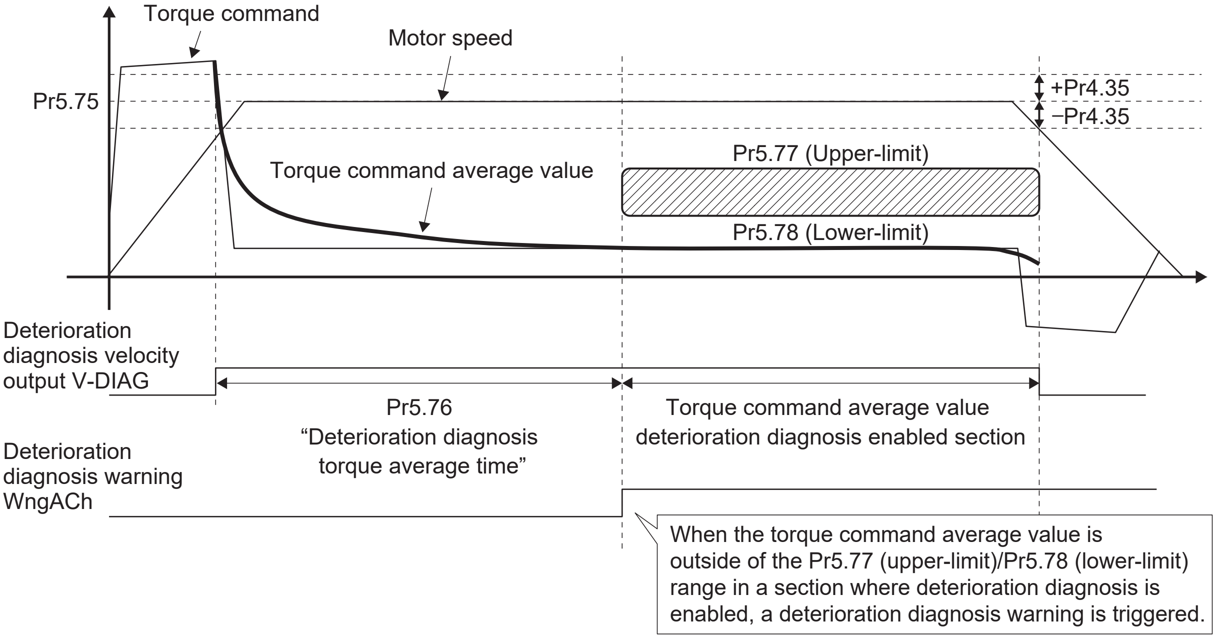
- Deterioration diagnosis warning for constant velocity torque command average value
  - Deterioration diagnosis velocity output (V-DIAG) is active when the motor speed is within the Pr4.35 “Speed coincidence range” range of Pr5.75 “Deterioration diagnosis velocity setting” .
  - When deterioration diagnosis velocity output (V-DIAG) is on, calculation of the torque command average value is started based on Pr5.76 “Deterioration diagnosis torque average time” whereby, after the set time for Pr5.76 “Deterioration diagnosis torque average time” has elapsed, the deterioration diagnosis judgment is activated based on the torque command average value. This continues while the deterioration diagnosis velocity output (V-DIAG) remains on, however it reverts to disabled when the output is turned off.
  - The upper-limit values and lower-limit values for torque command average value can be set by setting parameters for Pr5.77 “Deterioration diagnosis torque upper limit” and Pr5.78 “Deterioration diagnosis torque lower limit” respectively.

    If the torque command average value changes and upper-limit value or lower-limit values set by the parameters are exceeded, WngACh “Deterioration diagnosis warning” is generated.

    Note the following restrictions when setting upper-limit values and lower-limit values.
    - When the upper-limit value is set to the maximum value, the upper-limit judgment is disabled.
    - When the lower-limit value is set to the minimum value, the lower-limit judgment is disabled.
    - If upper-limit value ≤ lower-limit value, then both the upper-limit and lower-limit judgment are disabled.
  - Example of when deterioration diagnosis warning for torque command average value is not triggered



- Example of when deterioration diagnosis warning for torque command average value is triggered



## ■ Precautions

Since there may be delays in communication between this product and Set-up Support Software (PANATERM ver.7) , the torque command average value acquired via Set-up Support Software (PANATERM ver.7) may differ from the actual value inside this product (The value may be shown as 0 even when the actual value is not 0.).

## 8.10 Retracting Operation Function

This function sets retracting operation initiation and the content of that operation when the main power supply is off or the retracting operation signal is input.

Retracting operation is performed using the velocity and amount of movement set in the parameters when the retracting operation initialization conditions are met.

An alarm triggers after the retracting operation is completed.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |
| Other | ● Must be in servo-on state.<br>● Synchronous mode must be DC (SYNC0 event synchronization) or SM2 (SM2 event synchronization). For information on synchronous mode, see *“4.2.6 Communication Synchronous Mode”* .<br>● The start conditions specified in *“Operation”* must be met.<br>● The conditions for aborting start-up specified in *“Operation”* must not be met. |

**— Precautions —**

- Do not switch control modes during retracting operation.
- Operation cannot be guaranteed in the following circumstances.
  - When retracting operation is initiated during homing operation
  - When homing operation is initiated during retracting operation

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 08 | B | L/V trip selection upon main power off | 0 to 3 | — | Select whether to trip LV or servo-off when there is a main power supply alarm.<br>If the main power cut-off condition lasts longer than the time set in Pr7.14 “Main power off warning detection time” , set conditions for detection of main power off warning.<br>bit 0: Operation selection with main power supply OFF<br>0: Servo-off according to the settings for Pr5.07 “Sequence upon main power off” or Obj.6007h:00h “Abort connection option code” . Servo-on is then resumed when the main power is switched back on.<br>1: Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” detection<br>● Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is not triggered when the retracting operation is triggered by main power off. However, Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” may be triggered before the retracting operation finishes as the retracting operation runs off residual voltage from the capacitor.<br>bit 1: Main power off warning condition detection time<br>0: Main power off warning only detected when servo-on<br>1: Main power off warning always detected |
| 5 | 09 | C | Detection time of main power off | 20 to 2000 | ms | Set the main power alarm detection time.<br>● Before using the servo driver, confirm that this setup value is appropriate for the power supply environment. If this setup value is changed, reconfirm that the new setup value is appropriate for the power supply environment before use. For factory default values, see *“6.2 Object Dictionary List”* .<br>● Set this setup value to a value other than 2000 when main power off is used as the trigger. Main power off detection itself is disabled when this setup value is set to 2000, and the retracting operation is not executed. |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 85 | C | Retracting operation condition setting | -32768 to 32767 | — | Select the retracting operation initialization and stopping judgment conditions.<br>bits 3 to 0: Non-communication settings<br>0: Retracting operation by I/O input disabled<br>1: RET input<br>2: RET/HOME input<br>3: Main power off detection<br>4 to 15: Cannot be set<br>● If set to a value other than 0 to 3, Err87.3.0 is triggered.<br>bits 7 to 4: Communication-related setting<br>0: Retracting operation disabled because the conditions for triggering Err80.4.0 “PDO watchdog error protection” , Err80.7.0 “Synchronization signal error protection” , or Err85.2.0 “Lost link error protection” are met (when the conditions are met, Err80.4.0, Err80.7.0, or Err85.2.0 is triggered, and deceleration takes place in accordance with the Fault reaction option code.)<br>1: Conditions for generating Err80.4.0, Err80.7.0, or Err85.2.0 are met<br>2 to 15: Cannot be set<br>● If set to a value other than 0 to 1, Err87.3.0 is triggered.<br>bits 9 to 8: Judgment condition for stopping retracting operation<br>● Set a value from 0 to 3. For details, see the table below.<br>bits 15 to 10: Set to 0.<br>● If set to a value other than 0, Err87.3.0 is triggered. |

bits 9 to 8: Detailed determination conditions for stopping retracting operation

| bits 9 to 8 | Position command transfer judgment complete | Positioning complete (target reached) (*1) |
|---|---|---|
| 0 | Determine before filter | Disabled |
| 1 | Determine after filter | |
| 2 | Determine before filter | Enabled |
| 3 | Determine after filter | |

Use Obj.6041h:00h “Statusword” :bit 10 for positioning complete.

(Example) If bits 9 to 8 are set to 0, the position command transfer judgment takes place before the filter, and the retracting operation is judged to have stopped regardless of the positioning completion judgment.

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 86 | C | Retracting operation alarm setting | 0 to 7 | — | Sets the attribute for clearing retracting operation alarms.<br>bit 0: Err87.1.0 “Retracting operation completion (I/O)”<br>0: Cannot be cleared<br>1: Can be cleared<br>bit 1: Err87.2.0 “Retracting operation completion (communication)”<br>● Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is not triggered when the retracting operation is triggered by the main power off.<br>However, Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” may be triggered before the retracting operation finishes as the retracting operation runs off residual voltage from the capacitor.<br>0: Cannot be cleared<br>1: Can be cleared<br>bit 2: Err87.3.0 “Retracting operation error”<br>0: Cannot be cleared<br>1: Can be cleared |
| 8 | 01 | B | Profile linear acceleration constant | 1 to 429496 | 10000 Command unit/$s^2$ | Sets the acceleration for retracting operations.<br>Check that the set value is valid before initializing operation. |
| 8 | 04 | B | Profile linear deceleration constant | 1 to 429496 | 10000 Command unit/$s^2$ | Sets the deceleration for retracting operations.<br>Check that the set value is valid before initializing operation. |
| 8 | 17 | B | Relative movement of retracting operation | -2147483647 to 2147483647 | Command unit | Set the movement at retracting operation based on the command position before filter.<br>If the movement amount after the electronic gears is 0, an emergency stop is executed, and Err87.1.0 “Retracting operation completion (I/O)” and Err87.2.0 “Retracting operation completion (communication)” are triggered with no retracting operation taking place.<br>Check that the set value is valid before initializing operation.<br>This parameter is used as the relative displacement for pre-filter command position standard.<br>**— Precautions —**<br>● This parameter is signed data. Pay attention to the direction of retracting operation.<br>● To ensure safety, please confirm the direction of retracting operation with Pr8.17 set to a small value during initial configurations. |
| 8 | 18 | B | Retracting operation speed | 0 to 2147483647 | Command unit/s | Sets the speed at retracting operation.<br>If set to 0, 1 is set internally.<br>The maximum value is limited to the lesser of the Obj.6080h:00h “Max motor speed” and the max. motor speed by internal processing.<br>Check that the set value is valid before initializing operation. |

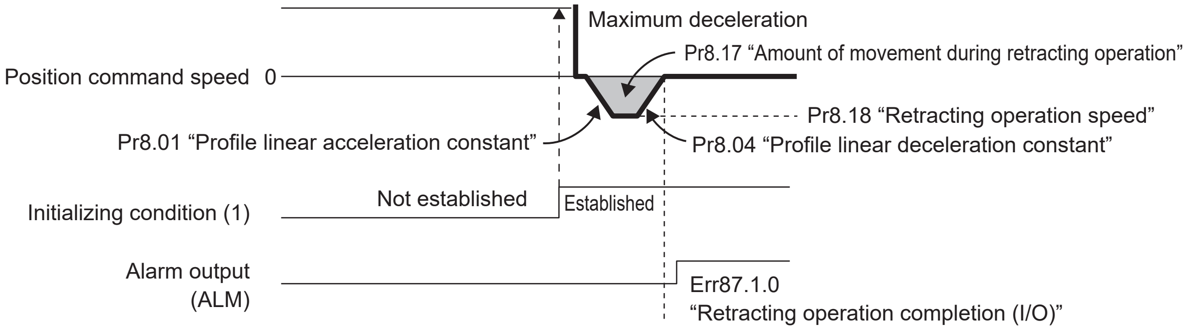
*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- Details of retracting operation
  - Retracting operation initialization conditions

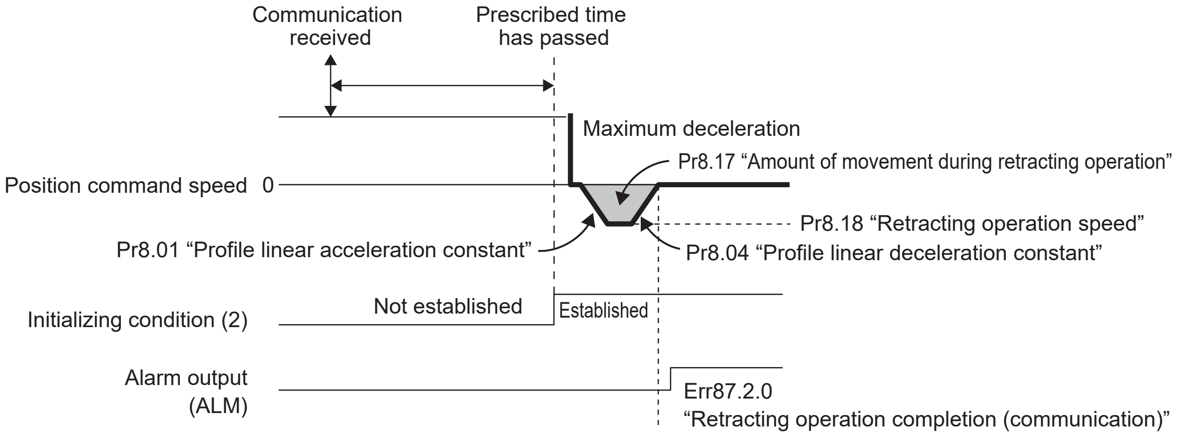
    If condition (1) or condition (2) is met, the retracting operation is initialized.

    - Condition (1)
      - If Pr6.85:bits 3 to 0 = 1 and retracting operation input (RET) is changed from off to on
      - If Pr6.85:bits 3 to 0 = 2 and conditions “1” or “2” below are met
        1. If the near home input (HOME) is on and the retracting operation input (RET) is changed from off -> on
        2. If, after the retracting operation input (RET) is changed from off -> on, the near home input (HOME) is changed from off -> on before Err87.1.0 “Retracting operation completion (I/O)” /Err87.2.0 “Retracting operation completion (communication)” /Err87.3.□ “Retracting operation error” is generated or before the retracting operation input (RET) is changed back to off
      - If Pr6.85:bits 3 to 0 = 3 and it is detected that main power supply is off



* Noted in pre-filter command waveform

- Condition (2)
  - If Pr6.85:bits 7 to 4 = 1 and a communication error (Err80.4.0 “PDO watchdog error protection” , Err80.7.0 “Synchronization signal error protection” , Err85.2.0 “Lost link error protection” ) is detected



* Noted in pre-filter command waveform

* Err80.4.0, Err80.7.0 and Err85.2.0 are also triggered, but Err87.2.0 is displayed on the front panel.

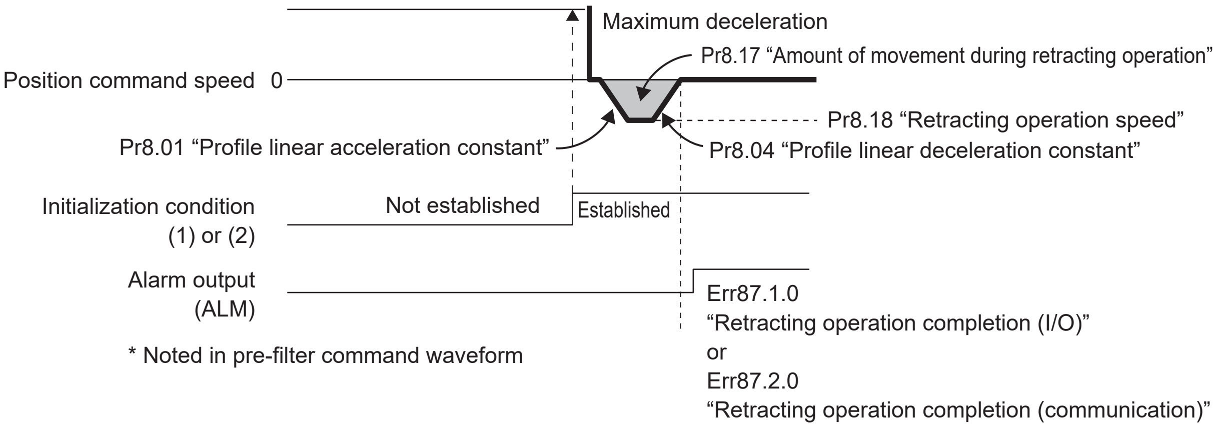
- External brake control when retracting operation is complete

  If Err87.1.0 “Retracting operation completion (I/O)” or Err87.2.0 “Retracting operation completion (communication)” is triggered when the retracting operation is completed, it is possible to prevent components such as the robot arm from falling by keeping the motor energized from the moment the brake is released (BRK-OFF) until the external brake actually engages.

For details, see *"8.17 Fall Prevention Function for When Alarm is Triggered"* .

- Retracting operation initialization during motor operation

  If retracting operation start-up conditions (1) or (2) are met during motor operation, it comes to a stop at the maximum deceleration and the retracting operation is performed.

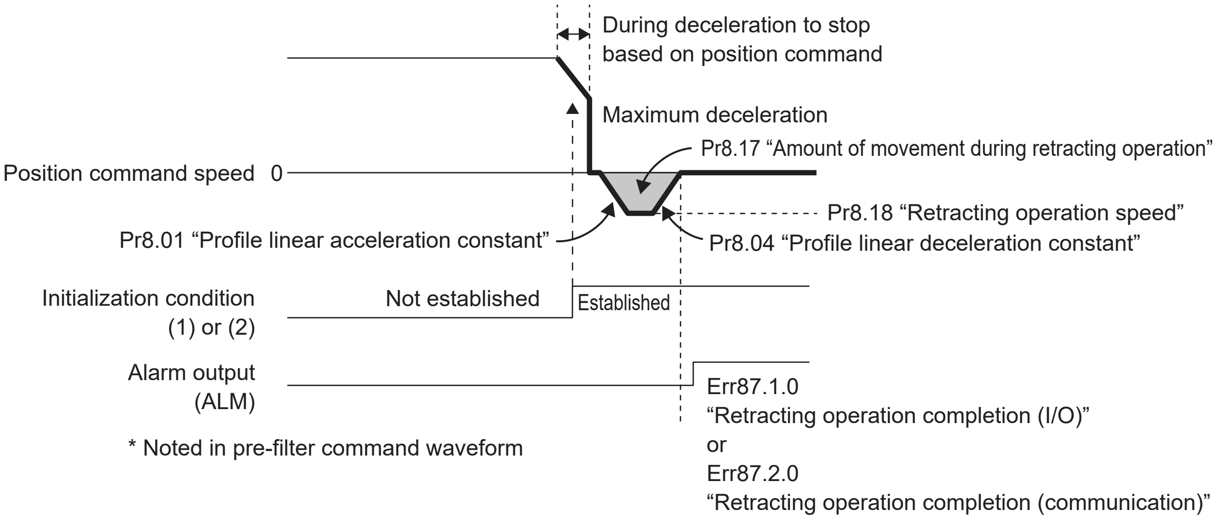


- Retracting operation initialization during motor deceleration

  If retracting operation start-up conditions (1) or (2) are met during the deceleration to stop operation, it comes to a stop at the maximum deceleration and the retracting operation is performed.

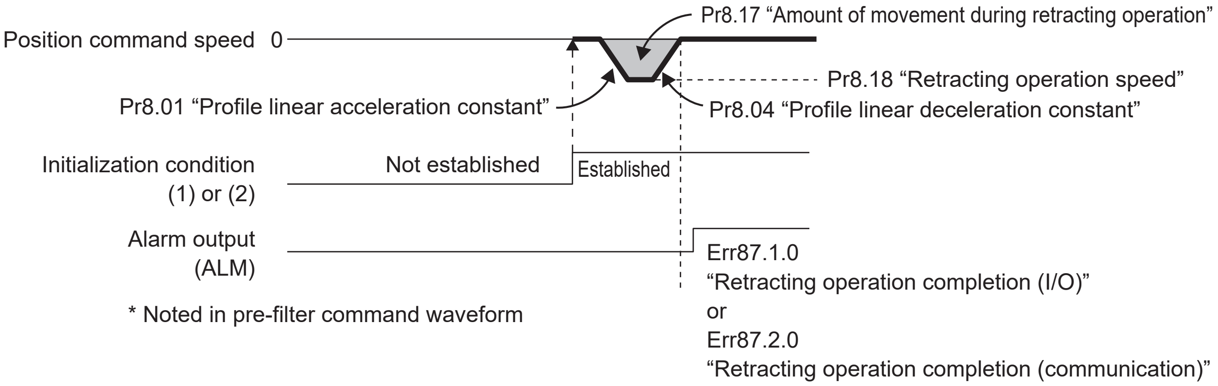
  Deceleration to stop means decelerating to a complete stop based on the position command.

  During deceleration to stop resulting from servo-off, main power turning off, or the triggering of an alarm, or deceleration to stop resulting from an over-travel inhibit input, the retracting operation will not be performed even if conditions (1) and (2) for starting the operation are met. Instead, the position command stops and deceleration begins in accordance with the deceleration sequence at alarm, after which Err87.3.□ "Retracting operation error" is triggered.



- Retracting operation from motor stop state

  The retracting operation will run when retracting operation initialization condition (1) or (2) is met during stop.



* Noted in pre-filter command waveform

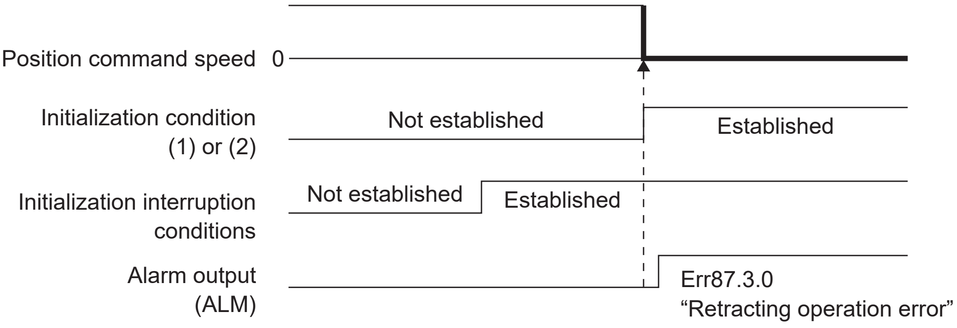
- Retracting operation initialization interruption conditions during motor operation

  If any of the following conditions are met for aborting start-up, the retracting operation will not be performed even if conditions (1) and (2) for starting the operation are met. Instead, the position command stops and deceleration begins in accordance with the deceleration sequence at alarm, after which Err87.3.☐ "Retracting operation error" is triggered.

  The conditions for aborting start-up of the retracting operation are as below.

  - Over-travel inhibit inputs (POT, NOT) are ON
  - During operations where communication is not enabled (trial run mode, etc.)
  - Servo-off
  - During deceleration with a higher priority than the retracting operation

    For high priority deceleration operation, see *"6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)"* .



* Noted in pre-filter command waveform

- Retracting operation termination conditions

  If any of the following conditions for terminating a retracting operation are met, the retracting operation will be terminated and the position command is stopped. Depending on the conditions for terminating execution, deceleration begins in accordance with the various deceleration sequences, after which Err87.3.☐ "Retracting operation error" is triggered.

  If the conditions for starting up the retracting operation are not met during the retracting operation, the current operation continues.

  The conditions for terminating a retracting operation are as below.

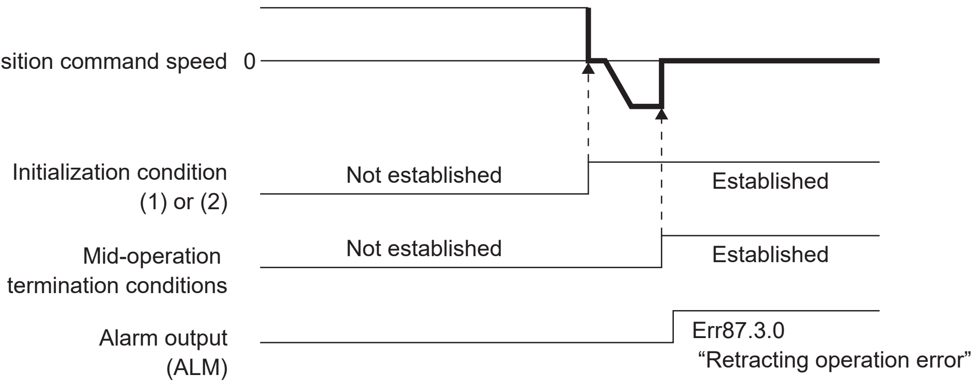
  - Over-travel inhibit inputs (POT, NOT) are ON
  - Alarm trigger
  - Main power supply is OFF (except when Pr6.85 bit 3 to 0 = 3)
  - STO input

    ● Because the PDS state during retracting operations becomes "Fault reaction active," it is not possible to turn to servo-off (PDS state transition by user command).

When using the retracting operation function, the forced alarm input (E-STOP) must be connected to ensure that the forced alarm input triggers Err87.0.0 “Forced alarm input protection” and stops the operation in an emergency.

- To prevent the retracting operation from being terminated due to the main power supply turning off, it is recommended to set Pr5.09 “Detection time of main power off” to 2000 (disabled).

  However, when the main power supply converter voltage across PN drops below the specified value, Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” will trigger and the retracting operation will terminate.



* Noted in pre-filter command waveform

- Alarms related to the retracting operation function

| Alarm number | | | Alarm name | Primary cause (*1) |
|---|---|---|---|---|
| Main | Sub | Primary cause | | |
| 80 | 4 | 0 | PDO watchdog error protection | Triggered when 0220h to 0223h “AL Event Request” :bit 10 is not turned ON within the time set by ESC registers 0400h “Watchdog Divider” and 0420h “Watchdog Time Process Data” during PDO communication (in SafeOP or OP state). |
| 80 | 7 | 0 | Synchronization signal error protection | When Obj.37B0h:00h “Communication function extended setup 7” :bit 7 (Pr7.110:bit 7) is set to 1, this alarm triggers when the number of interrupt process interruptions by SYNC0 or IRQ after completion of synchronization processing exceeds the threshold set by Obj.3742h:00h “Maximum continuation communication error” :bit 0 to 3 (Pr7.42 “Maximum continuation communication error” :bit 3 to 0). |
| 85 | 2 | 0 | Lost link error protection | Triggered after the ESM state transitions from Init -> PreOP if either Port0 or Port1 shows as “Lost link” (except ports that show as “Lost link” from the moment of transition from Init -> PreOP) and the time set in Obj.3743h:00h “Lost link detection time” has elapsed. |
| 87 | 1 | 0 | Retracting operation completion (I/O) | Triggered when the I/O retracting operation completes normally. |
| 87 | 2 | 0 | Retracting operation completion (communication) | Triggered when the communication retracting operation completes normally. |
| 87 | 3 | 0 to 6 | Retracting operation error | Triggered if the retracting operation was unable to initialize or was terminated. |

*1 For details on primary causes and handling, see *“10.2.3 Protection Function Details”* .

## ■ Precautions

- Check if the retracting operation is in progress with Obj.60FDh:00h “Digital inputs” :bit 25 “RET status [RET-STAT]” .

  0 = Retracting operation not initialized/complete

1 = During retracting operation

- Ensure there is no overlap between the home position and RET input position.
- During the retracting operation, Obj.6060h:00h “Modes of operation” is ignored and the control mode is forced to pp mode (Obj.6061h:00h “Modes of operation display” = 1).

  As a result, during retracting operations, actions such as the application of filters or the allocation of input and output signals will be those of pp (position control).

  Since Obj.6061h:00h “Modes of operation display” returns to the value at the start of the retracting operation when the retracting operation is completed, wait until retracting operation completes before changing control modes.

  Operation is not guaranteed if the control mode (Obj.6060h:00h “Modes of operation” ) is changed during a retracting operation.
- In incremental mode, after the retracting operation is completed (Err87.1.0 “Retracting operation completion (I/O)” , Err87.2.0 “Retracting operation completion (communication)” or Err87.3.☐ “Retracting operation error” is triggered), it will enter the homing incomplete state (homing attained = 0). Please re-run homing after clearing the alarm.
- The PDS state during retracting operations changes to Fault reaction active, and no external commands are accepted.

  For details on retracting operations, see *“Operation”* “Conditions for suspending retracting operations” in this section.

## 8.11 Deceleration to Stop Function

Sets the operation for during deceleration of the motor and after coming to a stop in cases such as when the main power supply is cut-off or an alarm is triggered when the PDS is in the Operation enabled state (servo-on state).

Uses the deceleration function (optional code) defined in CoE (CiA402) and the deceleration function on the servo side (this product) in combination.

The deceleration function on the servo side (this product) has three types of operation: dynamic brake (DB) stop, free run (DB OFF), and emergency stop. The deceleration function on the servo side (this product) is used to select the operation during deceleration and after stopping. The table below shows the deceleration function operations that can be selected during deceleration and after stopping.

| Deceleration trigger conditions | Selectable mid-deceleration operations | Selectable post-stop operations |
|---|---|---|
| Over-travel inhibit input | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF)<br>● Emergency stop | When a mid-deceleration operation is not an emergency stop, torque command for over-travel inhibit direction is 0.<br>When a mid-deceleration operation is an emergency stop, torque command is as normal. |
| Servo-off | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF)<br>● Emergency stop | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF) |
| Main power supply off | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF)<br>● Emergency stop | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF) |
| Alarm trigger | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF)<br>● Emergency stop | Set one of the following.<br>● Dynamic brake (DB) operation<br>● Free run (DB OFF) |

For details on each deceleration trigger condition, see the sections below.

During over-travel inhibit input: *“8.12 Deceleration to Stop Function for During Over-travel Inhibit Input (POT, NOT)”*

During servo-off: *“8.13 Deceleration to Stop Function for Servo Off”*

When main power supply off: *“8.14 Deceleration to Stop Function for When Main Power Supply is Off”*

When alarm is triggered: *“8.15 Deceleration to Stop Function for When Alarm is Triggered”*

The deceleration settings must be changed from their factory default values to values appropriate for the environment in which the device is used.

For the factory default values of each parameter and EtherCAT object, see *“6.2 Object Dictionary List”* .

For details, see *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

## 8.12 Deceleration to Stop Function for During Over-travel Inhibit Input (POT, NOT)

This function sets the mid-deceleration and post-stop operations after over-travel inhibit input (POT, NOT) is input.

In the homing operation, the edge of the over-travel inhibit input (POT, NOT) is used as the origin. For details on homing operations, see *“6.6.5.5 Homing Position Control Mode (hm mode)”* .

Over-travel inhibit status notifications can also be sent as warnings. For details, see *“10.2.3 Protection Function Details”* and *“4.2.7.3.2 Emergency Messages”* .

**— Precautions —**

- This must be set up so that the over-travel inhibit inputs (POT, NOT) can be input correctly.
  - Operation cannot be guaranteed if not set up correctly (NOT installed on the positive direction travel side, POT installed on the negative direction travel side, etc.).
  - Install the device at a position that takes into account the amount of movement required until deceleration stops.

    If the torque limit and deceleration set values are low, the amount of movement necessary until deceleration stops may increase.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

## ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 04 | C | Over-travel inhibit input setup | 0 to 2 | — | Sets the input operations for the over-travel inhibit inputs (POT, NOT).<br>Set according to the host device specification.<br>Normally set to 1 (disabled) in order for the host device to control the operation.<br>● 0: Servo (this product) side deceleration to stop (deceleration to stop during over-travel inhibit input)<br>Functions as POT -> positive direction travel inhibited, NOT -> negative direction travel inhibited. Stops as per Pr5.05 “Sequence at over-travel inhibit” when POT is input when operating in a positive direction. Operation is similar when NOT is input when operating in a negative direction.<br>● 1: CoE (CiA402)-side deceleration to stop<br>Functions as POT -> positive direction travel inhibited, NOT -> negative direction travel inhibited. If POT is input during positive direction travel or NOT is input during negative direction travel, the EtherCAT profile deceleration operation defined in CoE (CiA402) is executed to bring it to a stop. The deceleration constant differs for each control mode. For details, see Technical Reference Communication Specification “5.5.8.2.7 Sequence During Over-travel Inhibit Input (POT, NOT)” .<br>If Pr5.04 “Over-travel inhibit input setup” is set to anything other than 1 (CoE-side deceleration to stop) when POT is assigning functions to SI6 or NOT is assigning functions to SI7, Err38.2.0 “Over-travel inhibit input protection 3” is triggered.<br>● 2: Servo (this product) side deceleration to stop (deceleration to stop during alarm)<br>Inputting either POT or NOT triggers Err38.0.0 “Over-travel inhibit input protection 1” . |
| 5 | 05 | C | Sequence at over-travel inhibit | 0 to 2 | — | Sets the status for during deceleration and after coming to a stop after over-travel inhibit inputs (POT, NOT) are entered when Pr5.04 “Over-travel inhibit input setup” = 0. |
| 5 | 11 | B | Torque setup for emergency stop | 0 to 500 | % | Sets the torque limit for emergency stop.<br>The normal torque limit is used when this setup value is 0. |
| 6 | 98 | R | Function expansion setup 4 | -2147483648 to 2147483647 | — | bit 21: Expand conditions for canceling over-travel inhibit<br>0: Conventional specification<br>1: Expanded specification |
| 6 | 102 | B | Over-travel inhibit release level setup | 0 to 2147483647 | Command unit | Sets the position deviation amount for canceling the over-travel inhibited state using an absolute value when Pr5.04 “Over-travel inhibit input setup” = 1. If the absolute value for the position deviation amount is greater than the set value, the over-travel inhibit state cannot be canceled.<br>Err93.5.0 “Parameter setup error protection 4” is triggered when Pr5.04 “Over-travel inhibit input setup” ≠ 1 and Pr6.102 “Over-travel inhibit release level setup” > 0. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

## ■ Operation

- The table below shows the stopping method during deceleration and post-stop operations after over-travel inhibit input (POT, NOT) for each setting of operation Pr5.05 "Sequence at over-travel inhibit" when Pr5.04 "Over-travel inhibit input setup" = 0 (deceleration stop on servo-side (this product) (deceleration stop upon over-travel inhibit input)) is set.

—: None

| Pr5.04 (*3) | Pr5.05 | Mid-deceleration (*2) | | Post-stop (Approx. 30 r/min or below) | |
|---|---|---|---|---|---|
| | | Stopping method | Deviation | Post-stop operation | Deviation |
| 0 | Common | ● Forced to position control.<br>● Forced stop of position command generation processes<br>● When the slow stop function is enabled by Pr6.10 "Function expansion setup" bit 10 and bit 15, a slow stop is performed, not an emergency stop. For details, see *"8.19 Slow Stop Function"* .<br>● Obj.6041h:00h "Statusword" :bit 11 "internal limit active" is ON | — | ● Control mode is command-dependent<br>Stop a command in over-travel inhibit direction with the over-travel inhibit input set to ON. If a command is issued in the over-travel inhibit direction, the command is ignored.<br>● Obj.6041h:00h "Statusword" :bit 11 "internal limit active" is ON | — |
| | 0 | ● Dynamic brake (DB) operation<br>Stopping method is free run (DB OFF) in dynamic brake non-compatible models. | Clear (*1) | ● Torque command = 0 in over-travel inhibit direction | Retained |
| | 1 | ● Free run (DB OFF) | Clear (*1) | ● Torque command = 0 in over-travel inhibit direction | Retained |
| | 2 | ● Emergency stop<br>Emergency stop refers to a controlled immediate stop with servo-on.<br>The torque command value is limited during emergency stop by Pr5.11 "Torque setup for emergency stop" . When an emergency stop is performed, operation is normal from signal input until the emergency stop begins, and when the command stops simultaneous to the signal input, torque restricted by the normal torque limit may be output. Continue to send normal commands for at least 4 ms after the signal input to stop the motor with the torque set in torque setup for emergency stop.<br>The Pr6.14 "Emergency stop time at alarm" setting is invalid.<br>● Torque limit = Pr5.11 "Torque setup for emergency stop" | Clear (*1) | ● Torque limit and torque command are as normal | Retained |

*1 During deviation clearing, the process that makes the internal command position follow the feedback position is activated. At emergency stop and at the end of deceleration, position deviations/external scale deviations accumulated during deceleration are cleared.

*2 Deceleration period is the time required for the motor speed to decelerate to 30 r/min or less. Once the motor velocity drops below 30 r/min, any movement post-stop is treated as a stop state regardless of motor velocity.

*3 When the set value of Pr5.04 "Over-travel inhibit input setup" is 2, Err38.0.0 "Over-travel inhibit input protection 1" is triggered when POT or NOT is turned ON. Therefore, the system operates according to Pr5.10 "Sequence at alarm" , and not to this set value. Pr5.10 "Sequence at alarm" always has priority even if another error is triggered.

- Operation for when setting Pr5.04 "Over-travel inhibit input setup" = 1 (CoE-side (CiA402) deceleration to stop)

The table below shows the stopping method during deceleration and post-stop operations after over-travel inhibit input (POT, NOT) for each control mode.

| Pr5.04 (*2) | Control mode | Mid-deceleration (*1) | Post-stop (Approx. 30 r/min or below) |
|---|---|---|---|
| | | Stopping method | Post-stop operation |
| 1 | Common | ● Maintain servo-on state<br>● Obj.6041h:00h “Statusword” :bit 11 “internal limit active” is ON | ● Maintain servo-on state<br>● Obj.6041h:00h “Statusword” :bit 11 “internal limit active” is ON |
| | pp, pv, csp, csv | Deceleration to stop with Obj.6085h:00h “Quick stop deceleration” | ● Commands in the over-travel inhibit direction cannot be accepted.<br>Stop a command in over-travel inhibit direction with the over-travel inhibit input set to ON. In addition, commands issued in the in over-travel inhibit direction are ignored. |
| | tq, cst | Deceleration to stop with Obj.6087h:00h “Torque slope” | |

*1 Deceleration period is the time required for the motor speed to decelerate to 30 r/min or less. Once the motor velocity drops below 30 r/min, any movement post-stop is treated as a stop state regardless of motor velocity.

*2 When the set value of Pr5.04 “Over-travel inhibit input setup” is 2, Err38.0.0 “Over-travel inhibit input protection 1” is triggered when POT or NOT is turned ON. Therefore, the system operates according to Pr5.10 “Sequence at alarm” , and not to this set value. Pr5.10 “Sequence at alarm” always has priority even if another error is triggered.

- Operation for when setting Pr5.04 “Over-travel inhibit input setup” = 2 (Servo-side (this product) deceleration to stop (deceleration to stop upon alarm))

  Since Err38.0.0 “Over-travel inhibit input protection 1” is triggered when either POT or NOT is turned ON, it operates according to the deceleration to stop upon alarm operation, not the deceleration to stop operation by over-travel inhibit input (POT or NOT).

- Operation by setting Pr6.102 “Over-travel inhibit release level setup”

  Sets the position deviation amount using an absolute value for canceling the over-travel inhibit state when Pr5.04 “Over-travel inhibit input setup” = 1.

  If the absolute value for the position deviation amount is greater than the set value, the over-travel inhibit state cannot be canceled.

  If Pr5.04 “Over-travel inhibit input setup” ≠ 1 and Pr6.102 “Over-travel inhibit release level setup” > 0, then Err93.5.0 “Parameter setup error protection 4” occurs.

  - When Pr6.98:bit 21 “Expand conditions for canceling over-travel inhibit” = 0 (existing specification)

○: Operable, ×: Not operable, -: Not dependent

| POT, NOT input signal state | Pr6.102 (*1) (*2) | Position command direction (*6) | Amount of position deviation (*3) | Motor operation (*5) | |
|---|---|---|---|---|---|
| | | | | Positive direction | Negative direction |
| During POT input | = 0 | – | – | × | ○ |
| | > 0 | – | ≧ Pr6.102 | × | × |
| | | – | < Pr6.102 | × | ○ |
| During cancellation of POT input (*4) | = 0 | – | – | ○ | ○ |
| | > 0 | – | ≧ Pr6.102 | × | × |
| | | – | < Pr6.102 | ○ | ○ |
| During NOT input | = 0 | – | – | ○ | × |
| | > 0 | – | ≧ Pr6.102 | × | × |
| | | – | < Pr6.102 | ○ | × |
| During cancellation of NOT input (*4) | = 0 | – | – | ○ | ○ |
| | > 0 | – | ≧ Pr6.102 | × | × |
| | | – | < Pr6.102 | ○ | ○ |

- When Pr6.98:bit 21 “Expand conditions for canceling over-travel inhibit” = 1 (expanded specification)

○: Operable, ×: Not operable, -: Not dependent

| POT input signal state | Pr6.102 (*1) (*2) | Position command direction (*6) | Amount of position deviation (*3) | Motor operation (*5) | |
|---|---|---|---|---|---|
| | | | | Positive direction | Negative direction |
| During POT input | = 0 | — | — | × | ○ |
| | > 0 | — | ≧ Pr6.102 | × | × |
| | | — | < Pr6.102 | × | ○ |
| During cancellation of POT input (*4) | = 0 | — | — | ○ | ○ |
| | > 0 | — | ≧ Pr6.102 | × | × |
| | | Positive direction | < Pr6.102 | × | × |
| | | Stop or negative direction | < Pr6.102 | ○ | ○ |
| During NOT input | = 0 | — | — | ○ | × |
| | > 0 | — | ≧ Pr6.102 | × | × |
| | | — | < Pr6.102 | ○ | × |
| During cancellation of NOT input (*4) | = 0 | — | — | ○ | ○ |
| | > 0 | — | ≧ Pr6.102 | × | × |
| | | Negative direction | < Pr6.102 | × | × |
| | | Stop or positive direction | < Pr6.102 | ○ | ○ |

*1 When using a control mode other that csp control mode, set so that Pr6.102 “Over-travel inhibit release level setup” = 0.

*2 Take the device environment into consideration before setting any values.

Note that if the set value is low, the over-travel inhibit state may not be canceled.

*3 Amount of position deviation = Obj.607Ah:00h “Target position” + Obj.60B0h:00h “Position offset” - Obj.6064h:00h “Position actual value” |

*4 Indicates a state in which POT, NOT input has been canceled during over-travel inhibition due to POT, NOT input.

*5 Note that the motor begins operating when the conditions for canceling over-travel inhibition are satisfied.

*6 This means the direction of command change of Obj.607Ah:00h “Target position” .

## 8.13 Deceleration to Stop Function for Servo Off

This function sets the stopping method during deceleration and post-stop operations when the servo is off.

Deceleration to stop operations in the servo-off state are set by Obj.605Ah:00h “Quick stop option code” , Obj.605Bh:00h “Shutdown option code” , and Obj.605Ch:00h “Disable operation option code” .

The deceleration to stop function on the servo side (this product) activates if the above objects are set to 0. The deceleration to stop function on the CoE-side (CiA402) activates if set to anything other than 0.

This section provides information on the deceleration to stop function on the servo side (this product).

For more information on the CoE-side (CiA402) deceleration to stop function and other details, see *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Setup value

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 06 | B | Sequence at servo-off | 0 to 9 | — | Sets mid-deceleration and post-stop state after servo-off. |
| 5 | 11 | B | Torque setup for emergency stop | 0 to 500 | % | Sets the torque limit for emergency stop.<br>The normal torque limit is used when this setup value is 0. |
| 4 | 37 | B | Mechanical brake action at stalling setup | 0 to 10000 | ms | Sets the mechanical brake operating time at stalling setup. |
| 4 | 38 | B | Mechanical brake action at running setup | 0 to 32000 | ms | Sets the mechanical brake operating time at running setup. |
| 4 | 39 | B | Brake release speed setup | 30 to 3000 | r/min | Sets the threshold speed for determining mechanical brake output during operation. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Operation

- Details on Pr5.06 “Sequence at servo-off”

  If an alarm is triggered during servo-off, the system operates according to Pr5.10 “Sequence at alarm” .

  If the main power is turned off during servo-off, follow Pr5.07 “Sequence upon main power off” .

—: N/A

| Pr5.06 | Mid-deceleration (*3) | | Post-stop (Approx. 30 r/min or below) | |
|---|---|---|---|---|
| | Stopping method | Deviation | Post-stop operation | Deviation |
| Common | ● Forced to position control.<br>● Forced stop of position command generation processes (*7) | — | ● Forced to position control.<br>● Forced stop of position command generation processes (*7) | — |
| 0, 4 | ● Dynamic brake (DB) operation (*5) | Clear (*1) | ● Dynamic brake (DB) operation (*5) | Clear (*1) |

| Pr5.06 | Mid-deceleration (*3) | | Post-stop (Approx. 30 r/min or below) | |
|---|---|---|---|---|
| | Stopping method | Deviation | Post-stop operation | Deviation |
| 1, 5 | ● Free run (DB OFF) | Clear (*1) | ● Dynamic brake (DB) operation (*5) | Clear (*1) |
| 2, 6 | ● Dynamic brake (DB) operation (*5) | Clear (*1) | ● Free (DB OFF) | Clear (*1) |
| 3, 7 | ● Free run (DB OFF) | Clear (*1) | ● Free (DB OFF) | Clear (*1) |
| 8 | ● Emergency stop (*2) (*4) (*6) (*7)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Dynamic brake (DB) operation (*5) | Clear (*1) |
| 9 | ● Emergency stop (*2) (*4) (*6) (*7)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Free (DB OFF) | Clear (*1) |

*1 During deviation clearing, the process that makes the internal command position follow the feedback position is activated. As the motor may suddenly begin moving, please reconfigure the command coordinates on the host device side before running interpolation feed commands after servo-on.

*2 Emergency stop refers to a controlled immediate stop with servo-on. The torque command value is limited during emergency stop by Pr5.11 “Torque setup for emergency stop” .

When an emergency stop is performed, operation is normal from the servo-off command until the emergency stop begins, so torque restricted by the normal torque limit may be output.

Continue to send normal commands for at least 4 ms after the servo-off command input to stop the motor with the torque set in torque setup for emergency stop.

*3 Deceleration period is the time required for the motor speed to decelerate to 30 r/min or less.

Once the velocity drops below 30 r/min during deceleration, it comes to a stop, then transitions. Once operation shifts to post-stop, operation is as per post-stop regardless of the motor velocity.

*4 After emergency stop begins, continue to send servo-off commands (PDS command “Disable operation,” “Shutdown,” “Disable voltage,” “Quick Stop”) until the motor comes to a stop.

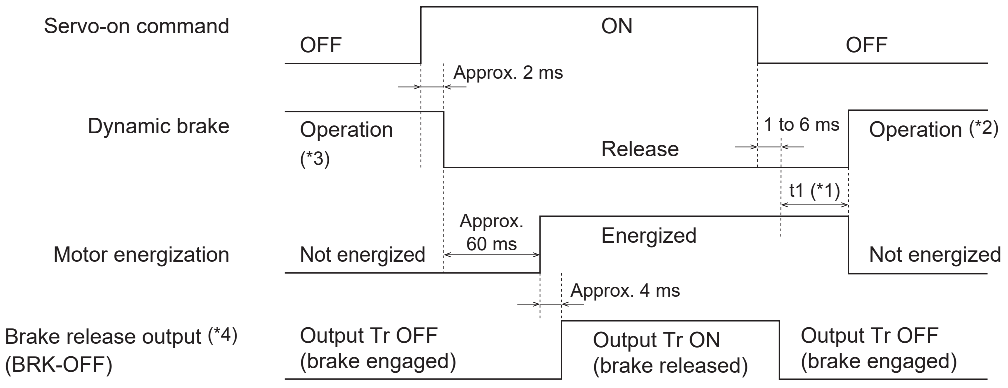
*5 Stopping method is free run (DB OFF) in dynamic brake non-compatible models.

*6 The Pr6.14 “Emergency stop time at alarm” setting is invalid.

*7 When the Slow Stop function is enabled with Pr6.10 “Function expansion setup” :bit 15 and bit 10, it will come to a stop using Slow Stop rather than making an emergency stop. For details, see *“8.19 Slow Stop Function”* .

- Servo-on/off operations when motor is stopped (servo lock) timing chart

(To turn the servo-on/off during normal operation, first stop the motor.)



*1 t1 depends on the set value for Pr4.37 “Mechanical brake action at stalling setup” .

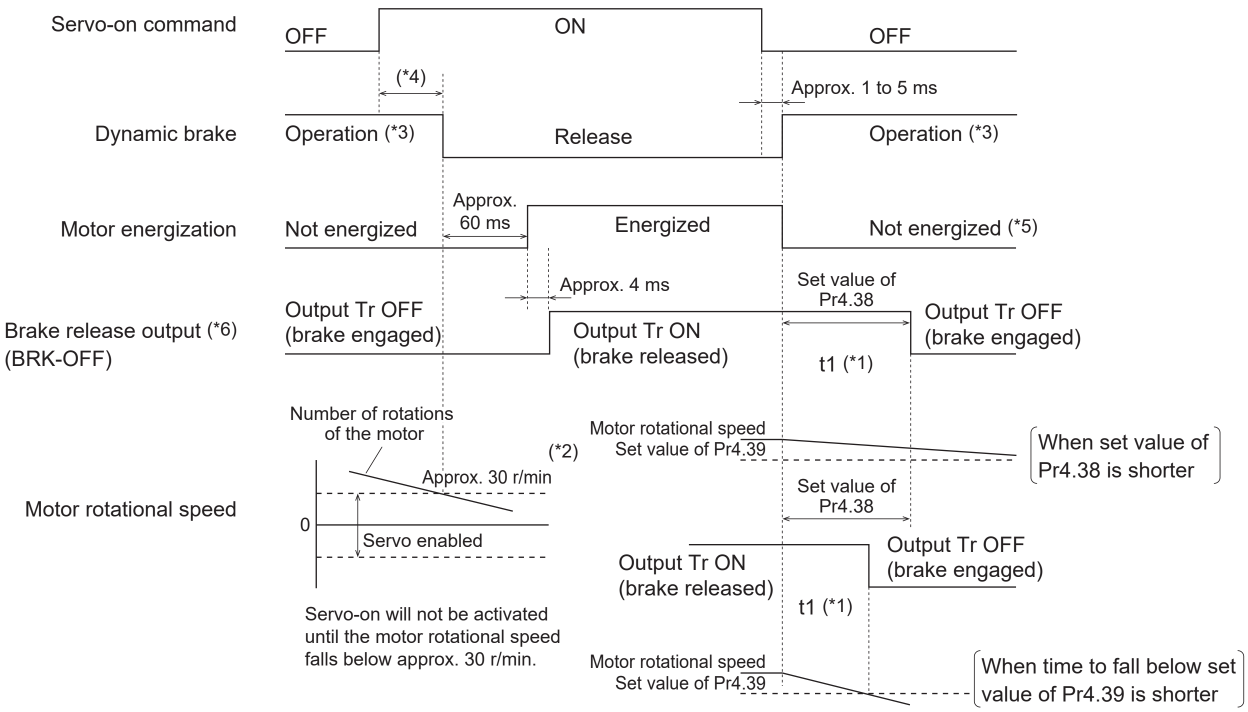
*2 The operation of the dynamic brake during servo-off depends on the set value of Pr5.06 “Sequence at servo-off” .

*3 Servo-on will not be activated until the motor rotational speed falls below approx. 30 r/min.

*4 The brake release output (BRK-OFF) is different from the Obj.60FEh: “Digital outputs” set brake command from EtherCAT communication. For details on the set brake command from Obj.60FEh: “Digital outputs” , see *“6.6.8.3.2 Digital outputs (60FEh)”* .

- Mid-motor rotation servo-on/off operations timing chart

(Emergency stop or trip timing. Not for repeated use.)



*1 t1 is the set value of Pr4.38 “Mechanical brake action at running setup” or the time at which the motor rotational speed drops below the time set to Pr4.39 “Brake release speed setup” , whichever comes first.

*2 Even when the servo-on command is turned on again while the motor is decelerating, transition to servo-on is not performed until the motor stops.

*3 The operation of the dynamic brake during servo-off depends on the set value of Pr5.06 “Sequence at servo-off” .

*4 Servo-on will not be activated until the motor rotational speed falls below approx. 30 r/min.

*5 The motor energization state during deceleration at servo-off depends on the set value of Pr5.06 “Sequence at servo-off” .

*6 The brake release output (BRK-OFF) is different from the Obj.60FEh: “Digital outputs” set brake command from EtherCAT communication. For details on the set brake command from Obj.60FEh: “Digital outputs” , see *“6.6.8.3.2 Digital outputs (60FEh)”* .

## 8.14 Deceleration to Stop Function for When Main Power Supply is Off

This function sets the stopping method during deceleration and post-stop operations after the main power supply is turned off.

Operation deceleration to stop operation in the main power off state differs depending on the combination of Obj.6007h:00h “Abort connection option code” , Pr5.07 “Sequence upon main power off” , Pr5.09 “Detection time of main power off” .

In principle, the deceleration function defined by CoE (CiA402) remains in effect until the deceleration function on the servo side (this product) is activated when an interruption to the main power supply AC (between L1 and L3) is detected. The deceleration function defined in the CoE (CiA402) does not work in the following cases.

- If set to “No action” by Obj.6007h = 0, the deceleration function on the servo side (this product) is activated.
- When the voltage across PN drops, Err13.0.0 Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” is triggered with the highest priority. Operation is initiated in accordance with Pr5.10 “Sequence at alarm” .

This section provides information on the deceleration function on the servo side (this product).

For more information on the CoE-side (CiA402) deceleration function and other details, see *“6.6.8.2 Option Code (Deceleration to Stop Sequence Setting)”* .

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Setup value

—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 07 | B | Sequence upon main power off | 0 to 9 | — | Sets mid-deceleration and post-stop state upon main power off. |
| 5 | 08 | B | L/V trip selection upon main power off | 0 to 3 | — | Select whether to trip LV or servo-off when there is a main power supply alarm.<br>If the main power cut-off condition lasts longer than the time set in Pr7.14 “Main power off warning detection time” , set conditions for detection of main power off warning.<br>bit 0: Operation selection with main power supply OFF<br>0: Servo-off according to the settings for Pr5.07 “Sequence upon main power off” or Obj.6007h:00h “Abort connection option code” . Servo-on is then resumed when the main power is switched back on.<br>1: Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” detection<br>● Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is not triggered when the retracting operation is triggered by main power off. However, Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” may be triggered before the retracting operation finishes as the retracting operation runs off residual voltage from the capacitor.<br>bit 1: Main power off warning condition detection time<br>0: Main power off warning only detected when servo-on<br>1: Main power off warning always detected |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 09 | C | Detection time of main power off | 20 to 2000 | ms | Set the main power alarm detection time.<br>Main power off detection is disabled when the setup value is 2000.<br>Before using the servo driver, confirm that this setup value is appropriate for the power supply environment. If this setup value is changed, reconfirm that the new setup value is appropriate for the power supply environment before use. For factory default values, see *“6.2 Object Dictionary List”* . |
| 5 | 11 | B | Torque setup for emergency stop | 0 to 500 | % | Sets the torque limit for emergency stop.<br>The normal torque limit is used when this setup value is 0. |
| 6 | 36 | R | Dynamic brake operation input setup | 0 to 1 | — | Enables/disables the dynamic brake (DB) operation input according to I/O. This function is available only when the main power is turned off.<br>0: Disabled<br>1: Enabled |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## Operation

Details of mid-deceleration and post-stop status after the main power supply has been turned off are shown in the table below.

—: N/A

| Pr5.07 | Mid-deceleration (*3) (*4) | | Post-stop (Approx. 30 r/min or below) (*4) | | |
|---|---|---|---|---|---|
| | Stopping method | Deviation | Post-stop operation | | Deviation |
| | | | Pr6.36 = 0 | Pr6.36 =1 | |
| Common | ● Forced to position control<br>● Forced stop of position command generation processes (*8) | — | ● Forced to position control<br>● Forced stop of position command generation processes (*8) | | — |
| 0, 4 | ● Dynamic brake (DB) operation (*5) | Clear (*1) | ● Dynamic brake (DB) operation (*5) | The dynamic brake operates according to the dynamic brake switching input (DB-SEL) state. (*6) | Clear (*1) |
| 1, 5 | ● Free run (DB OFF) | Clear (*1) | ● Dynamic brake (DB) operation (*5) | | Clear (*1) |
| 2, 6 | ● Dynamic brake (DB) operation (*5) | Clear (*1) | ● Free (DB OFF) | | Clear (*1) |
| 3, 7 | ● Free run (DB OFF) | Clear (*1) | ● Free (DB OFF) | | Clear (*1) |
| 8 | ● Emergency stop (*2) (*7) (*8)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Dynamic brake (DB) operation (*5) | | Clear (*1) |
| 9 | ● Emergency stop (*2) (*7) (*8)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Free (DB OFF) | | Clear (*1) |

*1 During deviation clearing, the process that makes the internal command position follow the feedback position is activated. Please re-configure the command coordinates on the host device side before running interpolation feed commands after servo-on. The motor may suddenly begin moving.

*2 Emergency stop refers to a controlled immediate stop with servo-on. The torque command value is limited during emergency stop by Pr5.11 “Torque setup for emergency stop” .

If the commands are stopped at the same time as main power off detection, torque restricted by the normal torque limit may be output. Continue to send normal commands for at least 4 ms after main power off detection to stop the motor with the torque set in torque setup for emergency stop.

*3 Deceleration period is the time required for the motor speed to decelerate to 30 r/min or less.

Once the motor transitions from a decelerating state to a stopping state with a velocity of less than 30 r/min, it operates according to the post-stop operation rather than relying on the velocity of the motor.

*4 If an alarm is triggered with the main power supply turned off, the system operates according to Pr5.10 “Sequence at alarm” .

When the main power supply is turned off in the servo-on state, Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” is triggered if Pr5.08 “L/V trip selection upon main power off” :bit 0 = 1, and the system operates according to Pr5.10 “Sequence at alarm” .

*5 Stopping method is free run (DB OFF) in dynamic brake non-compatible models.

*6 When Pr6.36 “Dynamic brake operation input setup” = 1, dynamic brake switching input (DB-SEL) is enabled.

By assigning DB-SEL to the control input signal, the product's built-in dynamic brake can be operated when the main power supply is OFF (See *“3.2.5.4.2 Control Input Signal”* for how to assign.).

When a-contact (Normally open: function OFF with no input) setting:

- Isolator is OFF (current is interrupted) → Dynamic brake is in effect
- Isolator is ON (current is flowing) → Dynamic brake is released

This input is disabled during servo-on, during trips, safety state or when the main power supply is switched on and will follow the normal sequence setting.

*7 The Pr6.14 “Emergency stop time at alarm” setting is invalid.

*8 When the slow stop function is enabled by Pr6.10 “Function expansion setup” bit 10 and bit 15, a slow stop is performed, not an emergency stop. For details, see *“8.19 Slow Stop Function”* .

## 8.15 Deceleration to Stop Function for When Alarm is Triggered

This function sets the stopping method during deceleration and post-stop operations when an alarm is triggered.

This function is intended for non-communication-related alarms. The stopping method during deceleration in the event of a communication-related alarm (Err80.□.□, Err81.□.□, Err85.□.□, Err88.□), and post-stop operations are set with Obj.605Eh:00h “Fault reaction option code” . For details, see *“6.6.8.2.6 Fault reaction option code (605Eh)”* .

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 10 | B | Sequence at alarm | 0 to 7 | — | Sets the mid-deceleration and post-stop operations when an alarm is triggered. |
| 4 | 38 | B | Mechanical brake action at running setup | 0 to 32000 | ms | Sets the mechanical brake operating time at running set-up. |
| 4 | 39 | B | Brake release speed setup | 30 to 3000 | r/min | Sets the threshold speed for determining mechanical brake output during operation. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Operation

The table below shows details of the status during deceleration and after stopping after an alarm occurs, excluding communication-related alarms (Err80.□.□, Err81.□.□, Err85.□.□, Err88.□.□).

—: None

<table>
<tr><th rowspan="2">Pr5.10</th><th colspan="3">Mid-deceleration (*3)</th><th colspan="2">Post-stop (Approx. 30 r/min or below)</th></tr>
<tr><th colspan="2">Stopping method</th><th>Deviation</th><th>Post-stop operation</th><th>Deviation</th></tr>
<tr><td>Common</td><td colspan="2">● Forced to position control<br>● Forced stop of position command generation processes (*6)</td><td>—</td><td>● Forced to position control<br>● Forced stop of position command generation processes (*6)</td><td>—</td></tr>
<tr><td>0</td><td colspan="2">● Dynamic brake (DB) operation (*5)</td><td>Clear (*1)</td><td>● Dynamic brake (DB) operation (*5)</td><td>Clear (*1)</td></tr>
<tr><td>1</td><td colspan="2">● Free run (DB OFF)</td><td>Clear (*1)</td><td>● Dynamic brake (DB) operation (*5)</td><td>Clear (*1)</td></tr>
<tr><td>2</td><td colspan="2">● Dynamic brake (DB) operation (*5)</td><td>Clear (*1)</td><td>● Free (DB OFF)</td><td>Clear (*1)</td></tr>
<tr><td>3</td><td colspan="2">● Free run (DB OFF)</td><td>Clear (*1)</td><td>● Free (DB OFF)</td><td>Clear (*1)</td></tr>
<tr><td rowspan="2">4</td><td>Operation A (*2)</td><td>● Emergency stop (*2) (*4) (*6)<br>● Torque limit = Pr5.11</td><td>Clear (*1)</td><td rowspan="2">● Dynamic brake (DB) operation (*5)</td><td rowspan="2">Clear (*1)</td></tr>
<tr><td>Operation B (*2)</td><td>● Dynamic brake (DB) operation (*5)</td><td>Clear (*1)</td></tr>
</table>

| Pr5.10 | Mid-deceleration (*3) | | | Post-stop (Approx. 30 r/min or below) | |
|---|---|---|---|---|---|
| | Stopping method | | Deviation | Post-stop operation | Deviation |
| 5 | Operation A (*2) | ● Emergency stop (*2) (*4) (*6)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Dynamic brake (DB) operation (*5) | Clear (*1) |
| | Operation B (*2) | ● Free run (DB OFF) | Clear (*1) | | |
| 6 | Operation A (*2) | ● Emergency stop (*2) (*4) (*6)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Free (DB OFF) | Clear (*1) |
| | Operation B (*2) | ● Dynamic brake (DB) operation (*5) | Clear (*1) | | |
| 7 | Operation A (*2) | ● Emergency stop (*2) (*4) (*6)<br>● Torque limit = Pr5.11 | Clear (*1) | ● Free (DB OFF) | Clear (*1) |
| | Operation B (*2) | ● Free run (DB OFF) | Clear (*1) | | |

*1 During deviation clearing, the process that makes the internal command position follow the feedback position is activated. Please re-configure the command coordinates on the host device side before running interpolation feed commands after servo-on. The motor may suddenly begin moving.

*2 When this setting value is 4 to 7, either operation A or B is performed in the event of an alarm.

When an emergency stop alarm triggers, an emergency stop is performed as per operation A.

When a not-supported emergency stop alarm is triggered, dynamic brake (DB) or free run will run as per operation B (See *“8.16 Emergency Stop Function for When Alarm is Triggered”* ).

Please maintain the main circuit power supply until deceleration to stop.

For details on alarms relating to emergency stops, see *“10.2.2 List of Protection Functions”* .

*3 Deceleration period is the time required for the motor speed to decelerate to 30 r/min or less. Once the motor velocity drops below 30 r/min, any movement post-stop is treated as a stop operation regardless of motor velocity.

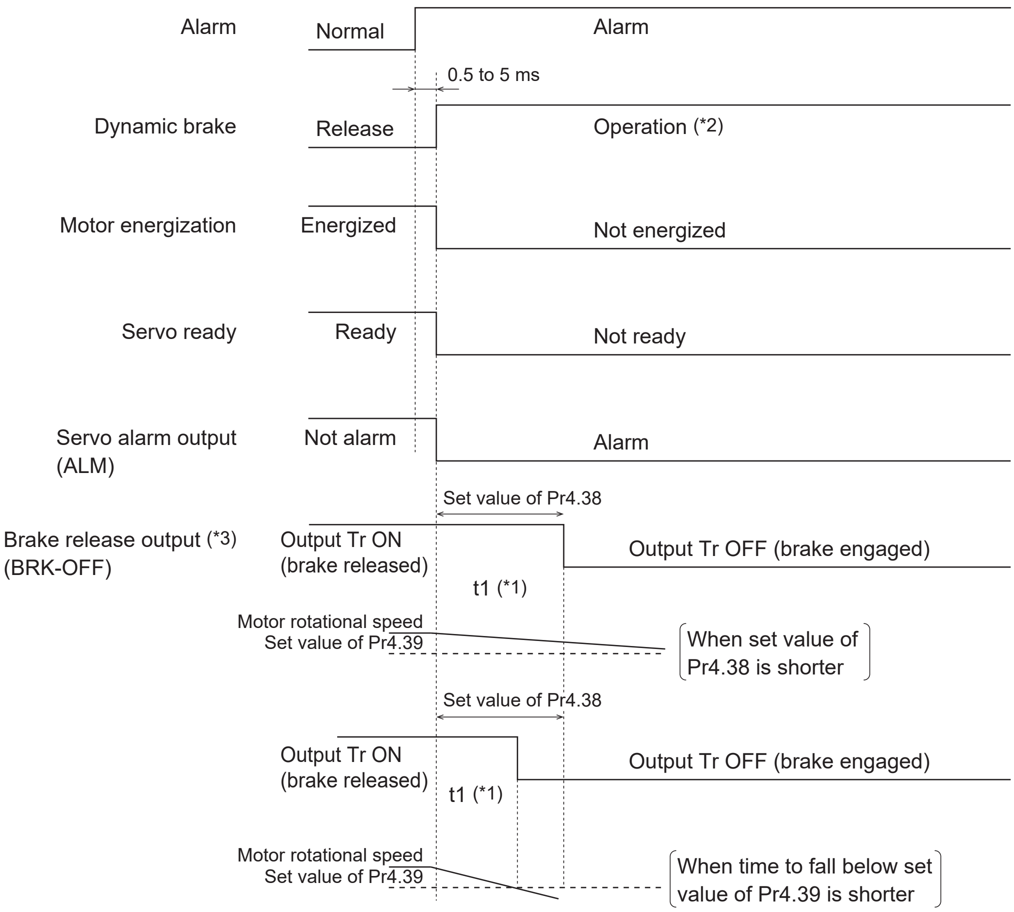
*4 If an emergency stop alarm is triggered during a dynamic brake (DB) operation or a free run operation as a result of the over-travel inhibit input sequence, sequence at servo-off, or sequence upon main power off, operation B is performed.

*5 Stopping method is free run (DB OFF) in dynamic brake non-compatible models.

*6 When the Slow Stop function is enabled with Pr6.10 “Function expansion setup” bit 15, bit 10, it will come to a stop using Slow Stop rather than making an emergency stop. For details, see *“8.19 Slow Stop Function”* .

## ■ Error (alarm) timing chart (servo-on command state) (DB deceleration, free run deceleration)

The below timings will vary dependent on the setting of Pr5.10 “Sequence at alarm” .



*1 t1 is the value set to Pr4.38 “Mechanical brake action at running setup” or the time at which the motor rotational speed drops below the time set to Pr4.39 “Brake release speed setup” , whichever comes first.

*2 The operation of dynamic brake when an alarm is triggered depends on the set value of Pr5.10 “Sequence at alarm” .

*3 The brake release output (BRK-OFF) is different from the Obj.60FEh: “Digital outputs” set brake command from EtherCAT communication. For details on the set brake command from Obj.60FEh: “Digital outputs” , see *“6.6.8.3.2 Digital outputs (60FEh)”* .

## 8.16 Emergency Stop Function for When Alarm is Triggered

This function sets the stopping operations when an emergency stop alarm is triggered.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Setup value

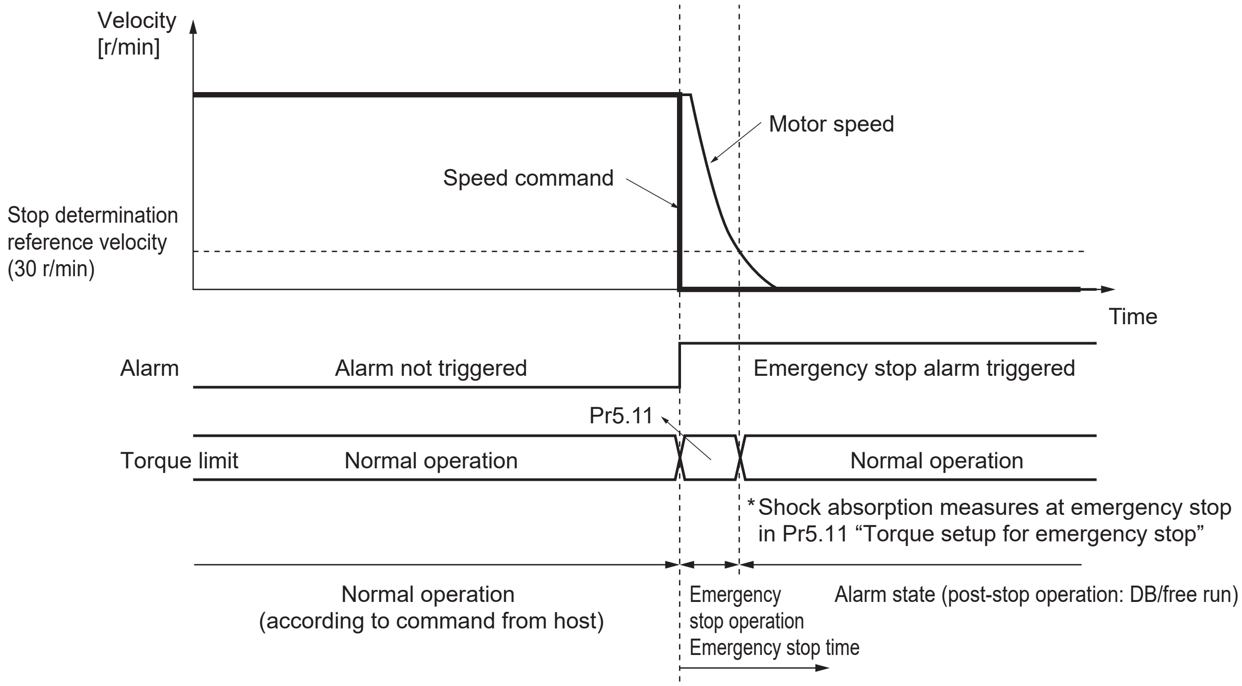
—: N/A

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 10 | B | Sequence at alarm | 0 to 7 | — | Sets the mid-deceleration and post-stop operations when an alarm is triggered.<br>Emergency stop is enabled when the setup value is 4 to 7.<br>For details, see *“8.15 Deceleration to Stop Function for When Alarm is Triggered”* . |
| 5 | 11 | B | Torque setup for emergency stop | 0 to 500 | % | Sets the torque limit for emergency stop.<br>The normal torque limit is used when this setup value is 0. |
| 5 | 13 | B | Over-speed level setup | 0 to 20000 | r/min | Sets the detection level for Err26.0.0 “Overspeed protection” .<br>If the motor speed exceeds this setup value, Err26.0.0 “Overspeed protection” is triggered.<br>When the setup value is 0, the internal overspeed protection level value is used.<br>The internal value is restricted by the overspeed level of the applicable motor. |
| 6 | 14 | B | Emergency stop time at alarm | 0 to 1000 | ms | Sets the time allowed to complete emergency stop when an alarm is triggered. An alarm state is forced if this set value is exceeded.<br>When this setup value is 0, an immediate alarm state will be triggered without executing an emergency stop. |
| 6 | 15 | B | 2nd overspeed level setting | 0 to 20000 | r/min | Sets the detection level for Err26.1.0 “2nd Overspeed protection” . If the motor speed exceeds this setup value, Err26.1.0 “2nd Overspeed protection” is triggered.<br>When the setup value is 0, the internal overspeed protection level value is used. The internal value is restricted by the overspeed level of the applicable motor. |
| 4 | 38 | B | Mechanical brake action at running setup | 0 to 32000 | ms | Sets the mechanical brake operating time at running setup. |
| 4 | 39 | B | Brake release speed setup | 30 to 3000 | r/min | Sets the threshold speed for determining mechanical brake output during operation. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- ● Emergency stop operation when an emergency stop alarm is triggered



* After an emergency stop alarm is triggered, if the speed has not dropped to 30 r/min or less after the time set by Pr6.14 "Emergency stop time at alarm" , an alarm state is triggered. The system also enters the alarm state if a non-emergency stop alarm is triggered in this product during emergency stop.

When an emergency stop alarm is triggered, operation is normal (normal torque limit is enabled) until the emergency stop operation begins. If the command is stopped while normal operation is in progress, torque limited by the normal torque limit may be output.

In order to stop at the torque limit set in Pr5.11 "Torque setup for emergency stop" when an emergency stop alarm is triggered, the command should be sent continuously for at least 4 ms after the alarm notification.

For example, please do not run the following processes.

- Stop commands at the same time as forced alarm input (E-STOP) is turned on.

- ● Pr5.13 "Over-speed level setup" and Pr6.15 "2nd overspeed level setting" settings

The motor may not stop as normal, even if the emergency stop function is used.

As shown below, when the motor speed exceeds Pr5.13 "Over-speed level setup" , although the emergency stop function is activated, the motor speed may increase if it cannot be normally controlled.

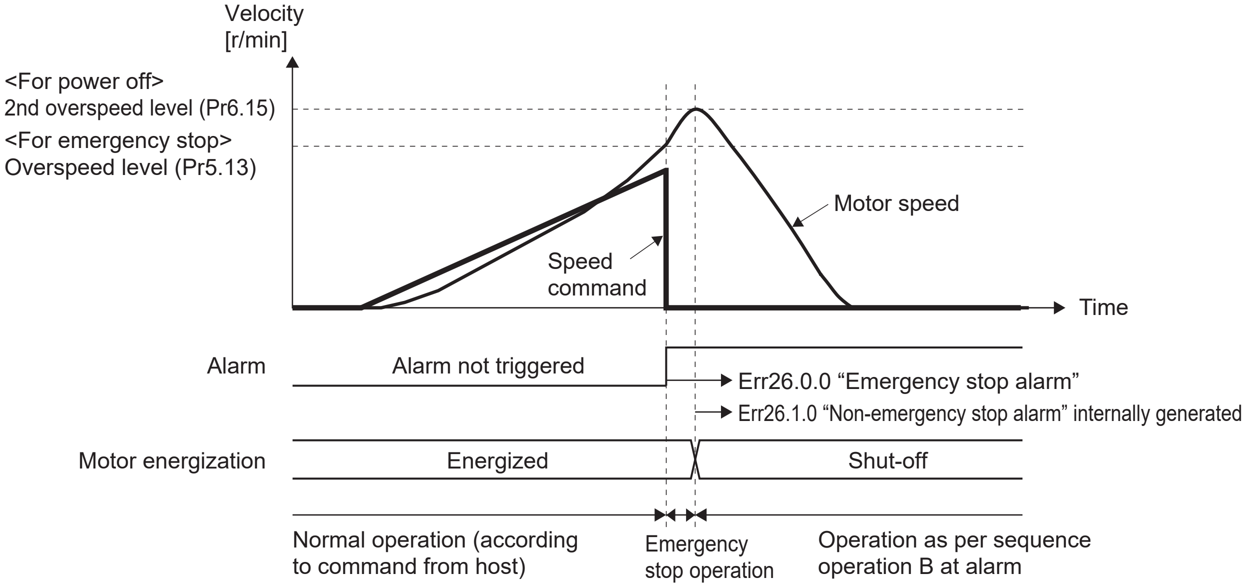
Err26.1.0 "2nd Overspeed protection" is provided as a safety measure in such cases.

Because Err26.1.0 "2nd Overspeed protection" is a non-emergency stop alarm, it shuts off motor current and stops according to the sequence at alarm operation B. In Pr6.15 "2nd overspeed level setting" , set the allowable overspeed level.

Set Pr5.13 "Over-speed level setup" to a low value, leaving a sufficient margin for Pr6.15 "2nd overspeed level setting" . Err26.0.0 "Overspeed protection" and Err26.1.0 "2nd Overspeed protection" may be detected at the same time if the margin is too small or the set values are the same.

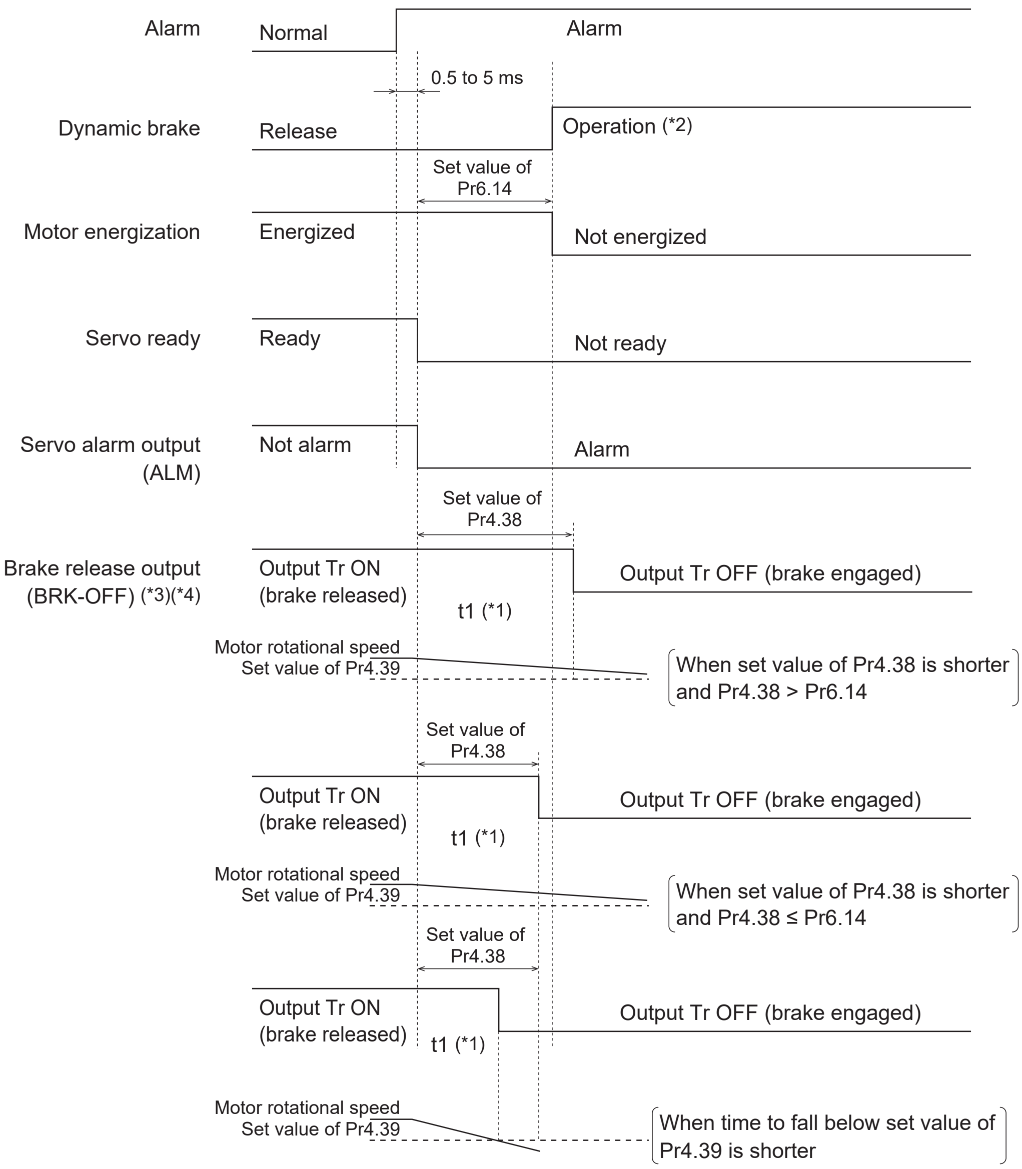
If this happens, Err26.0.0 "Overspeed protection" is shown on the display, but an emergency stop is not performed as the non-emergency stop alarm takes priority in operations.

If the set value of Pr6.15 "2nd overspeed level setting" is lower than that of Pr5.13 "Over-speed level setup" , Err26.1.0 "2nd Overspeed protection" is triggered before Err26.0.0 "Overspeed protection" , so emergency stop is not performed.



* When the velocity exceeds the velocity set in Pr6.15 “2nd overspeed level setting” , turns off the current and operates according to sequence at alarm operation B.

- Error (alarm) timing chart (servo-on command state) (emergency stop operation)
  - The below timings will vary dependent on the setting of Pr5.10 “Sequence at alarm” .
  - For operation timing charts for when the Slow Stop function in enabled, see *“8.19 Slow Stop Function”* .



*1 t1 is the set value of Pr4.38 “Mechanical brake action at running setup” or the time at which the motor speed drops below the time set to Pr4.39 “Brake release speed setup” , whichever comes first.

*2 The operation of dynamic brake when an alarm is triggered depends on the set value of Pr5.10 “Sequence at alarm” .

*3 The brake release output (BRK-OFF) is different from the Obj.60FEh: “Digital outputs” set brake command from EtherCAT communication. For details on the set brake command from Obj.60FEh: “Digital outputs” , see *“6.6.8.3.2 Digital outputs (60FEh)”* .

*4 We recommend a setting where Pr4.38 “Mechanical brake action at running setup” = Pr6.14 “Emergency stop time at alarm” .

When Pr4.38 ≤ Pr6.14, the brake is engaged once the time set for Pr4.38 has passed.

When Pr4.38 > Pr6.14, the brake is not engaged even when the time set for Pr4.38 has passed, and will engage when shifting to an un-powered state.

## 8.17 Fall Prevention Function for When Alarm is Triggered

In this product, when an alarm is triggered, the brake release output (BRK-OFF) is turned OFF and the external brake operates, but it takes some time until the external brake operates after the brake release output (BRK-OFF) is turned OFF.

In the event of an alarm, motor energization is interrupted, so vertical axes of robot arms or other parts cannot be held and will fall until the external brake is activated.

This function uses the emergency stop of the deceleration stop function in the event of an alarm to keep the motor energized until the external brake is activated in order to prevent robot arms or other parts from falling in the event of an alarm.

By keeping the motor energized, vertical axes of robot arms or other parts can be held in place until the external brake is activated.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |
| Other | ● The alarm that has been triggered is not a non-emergency stop alarm.<br>● The deceleration to stop function in the event of an alarm is set to emergency stop. See *“8.15 Deceleration to Stop Function for When Alarm is Triggered”* and *“8.16 Emergency Stop Function for When Alarm is Triggered”* for details. |

### ■ Setup value

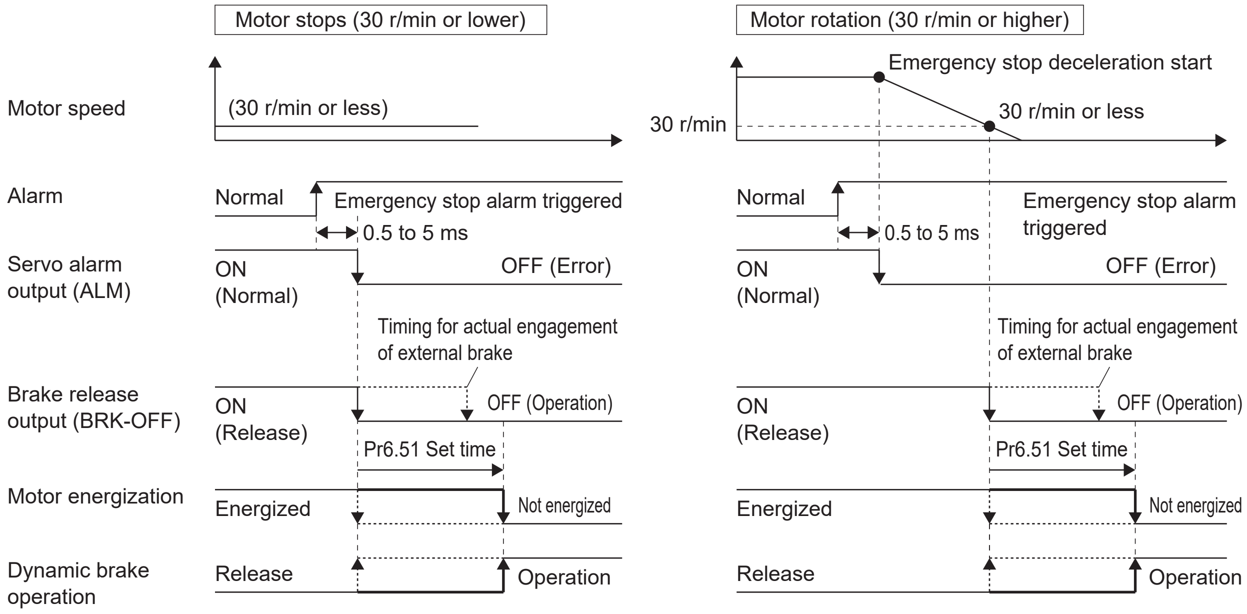
—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 10 | B | Sequence at alarm | 0 to 7 | — | Set mid-deceleration and post-stop states when an alarm is triggered.<br>Emergency stop is enabled when the setup value is 4 to 7. |
| 6 | 10 | B | Function expansion setup | -32768 to 32767 | — | Sets the bit for the fall prevention function.<br>bit 10: Fall prevention function during an alarm<br>0: Disabled<br>1: Enabled<br>Normally set to 1 to enable the fall prevention function. |
| 6 | 51 | B | Wait time for emergency stop | 0 to 10000 | ms | Sets the time to maintain the motor energization when an emergency stop alarm is triggered after turning OFF the brake release output (BRK-OFF).<br>If this setting value is 0, the fall prevention function is disabled.<br>**— Precautions —**<br>● Although this parameter is enabled even if Pr6.10 “Function expansion setup” : bit 10 is set to a value other than 1, Pr6.10 “Function expansion setup” : bit 10 must be set to 1 to enable the fall prevention function. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## ■ Operation

- For details on alarms relating to emergency stops, see *“10.2.2 List of Protection Functions”* .
- Fall prevention operation timings for emergency stop alarms are given in the figure below.



## 8.18 Fall Prevention Function for Servo-on

This function eliminates the delay in torque command start-up at the servo-on command input timing when turning on from servo-off, and prevents the equipment from falling. This function is enabled by updating the torque filter with the value of Obj.60B2h:00h “Torque offset” when the servo is off.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, and full-closed control |

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 7 | 24 | C | Communication function extended setup 3 | -32768 to 32767 | — | bit 7: TFF clear ON/OFF selection from host device<br>0: Clear<br>1: Updates using the Obj.60B2h set value |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ Related objects

| Index | Sub-Index | Name | Units | Range | Data type | Access | PDO | Op-mode | EEPROM |
|---|---|---|---|---|---|---|---|---|---|
| 37B3h | 00h | Torque offset filter | 0.01 ms | 0 to 6400 | I16 | rw | NO | csp<br>pp<br>hm<br>ip<br>csv<br>pv | YES |
| | | ● Sets the time constant of the first order lag filter for Obj.60B2h:00h “Torque offset” .<br>Disabled when the set value is 0 to 3. | | | | | | | |
| 60B2h | 00h | Torque offset | 0.1% | -32768 to 32767 | I16 | rw | RxPDO | ALL | Yes |
| | | ● Set the torque command offset value (torque feedforward).<br>● The torque feedforward value is 0 during deceleration in over-travel inhibition operations (during emergency stops). | | | | | | | |

## 8.19 Slow Stop Function

This function allows for control to remain functioning in servo-on, allowing the motor to stop smoothly, when over-travel inhibit input, servo-off, main power supply off, or an emergency stop alarm is detected with emergency stop settings.

### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● Position control, velocity control, torque control |
| Other | ● Must be in servo-on state.<br>● Non-servo parameters such as torque limit must be set properly to ensure the motor rotates normally. |

**— Precautions —**

- During an emergency stop, it is forced to position control.
- The Slow Stop function is not supported with full-closed control, so full-closed control must be disabled.

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 05 | C | Sequence at over-travel inhibit | 0 to 2 | — | Over-travel inhibit input when Pr5.04 “Over-travel inhibit input setup” = 0<br>Sets mid-deceleration and post-stop state after (POT, NOT) input.<br>Set to emergency stop when Slow Stop function is enabled. |
| 5 | 06 | B | Sequence at servo-off | 0 to 9 | — | Sets mid-deceleration and post-stop state after servo-off.<br>Set to emergency stop when Slow Stop function is enabled. |
| 5 | 07 | B | Sequence upon main power off | 0 to 9 | — | Sets mid-deceleration and post-stop state upon main power off.<br>Set to emergency stop when Slow Stop function is enabled. |
| 5 | 10 | B | Sequence at alarm | 0 to 7 | — | Sets the mid-deceleration and post-stop operations when an alarm is triggered.<br>Set to emergency stop when Slow Stop function is enabled. |
| 5 | 56 | B | Slow stop deceleration time setting | 0 to 10000 | ms/(1000 r/min) | Sets deceleration time for Slow Stop deceleration processing.<br>When Pr6.10 “Function expansion setup” :bit 15 “Slow stop function” = 1 is set, this parameter is enabled. |
| 5 | 57 | B | Slow stop S-shape acceleration and deceleration setting | 0 to 1000 | ms | Sets the deceleration processing S-curve time during Slow Stop.<br>When Pr6.10 “Function expansion setup” :bit 15 “Slow stop function” = 1 is set, this parameter is enabled. |

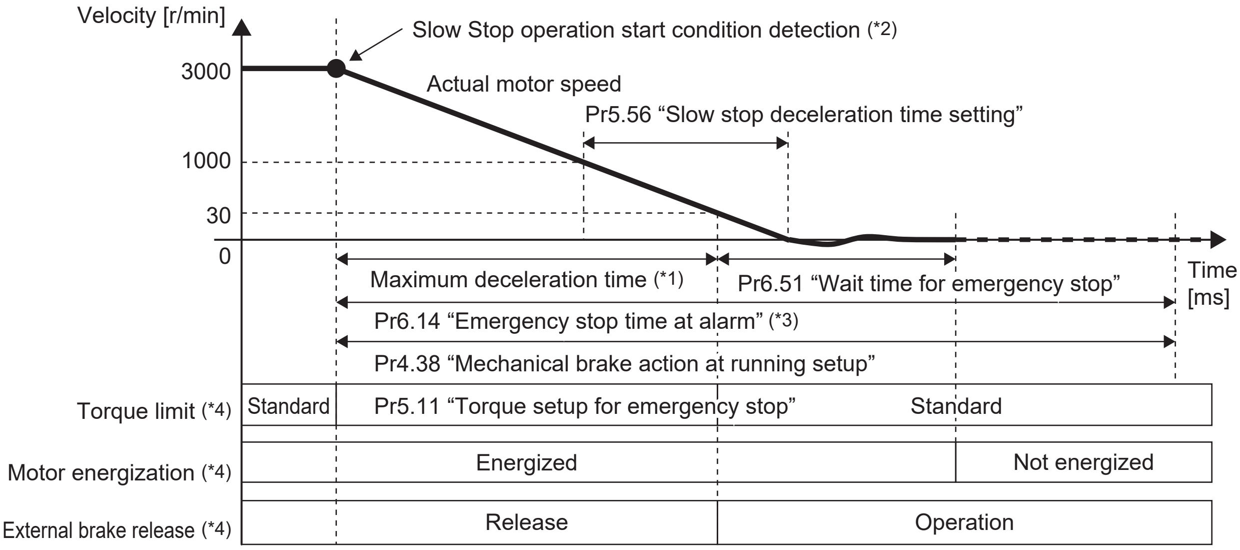
| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 10 | B | Function expansion setup | -32768 to 32767 | — | bit 10: Fall prevention function during an alarm<br>0: Disabled<br>1: Enabled<br>Please normally set to 1 when the Slow Stop function is enabled.<br>bit 15: Slow stop function<br>0: Disabled<br>1: Enabled<br>Set to 0 with full-closed control. |
| 6 | 14 | B | Emergency stop time at alarm | 0 to 1000 | ms | Sets the time allowed to complete emergency stop when an alarm is triggered. An alarm state is forced if this set value is exceeded.<br>When this setup value is 0, an alarm state is triggered without executing an emergency stop.<br>When using the Slow Stop function, ensure the setting is sufficiently longer than the maximum deceleration time, as the motor speed will have a delay from the deceleration to stop command.<br>This parameter is only enabled by the deceleration to stop function when an alarm is triggered.<br>Disabled with drive inhibition deceleration to stop function, servo-off deceleration to stop function, and main power off deceleration to stop function.<br>For maximum deceleration times, see *"Operation"* in this section. |
| 4 | 38 | B | Mechanical brake action at running setup | 0 to 32000 | ms | Sets the mechanical brake operating time at running setup. |

*1 For attributes, see *"6.2 Object Dictionary List"* .

## ■ Operation

- Slow Stop operation during alarm

  Operation examples are shown in the figure below.



*1 The maximum deceleration time is approximately the value obtained by the following formula:

Maximum deceleration time [ms]

$$= \frac{\text{Maximum velocity under normal operation pattern [r/min]} \times \text{Pr5.56 [ms/(1000 r/min)]}}{1000} + \text{Pr5.57 [ms]}$$

*2 Refers to detection of the following conditions:

- Over-travel inhibit input with Slow Stop function enabled setting
- Servo-off with Slow Stop function enabled setting
- Main power off with Slow Stop function enabled setting
- Emergency stop alarm triggered with Slow Stop function enabled setting

For details on alarms relating to emergency stops, see *“10.2.2 List of Protection Functions”* .

*3 Set Pr6.14 “Emergency stop time at alarm” to a value that is sufficiently longer in length than the completion of the Slow Stop operation. The stop judgment under Slow Stop operation is based on actual velocity. Therefore, the time required for the actual deceleration may take longer than the maximum deceleration time.

In the emergency stop operation from emergency stop alarm, if the emergency stop duration exceeds Pr6.14 “Emergency stop time at alarm” , an alarm state is triggered regardless of the actual motor velocity.

The system also immediately enters the alarm state if a non-emergency stop alarm is triggered in the driver during emergency stop.

*4 There is a maximum variance of about 5 ms in the switching timing.

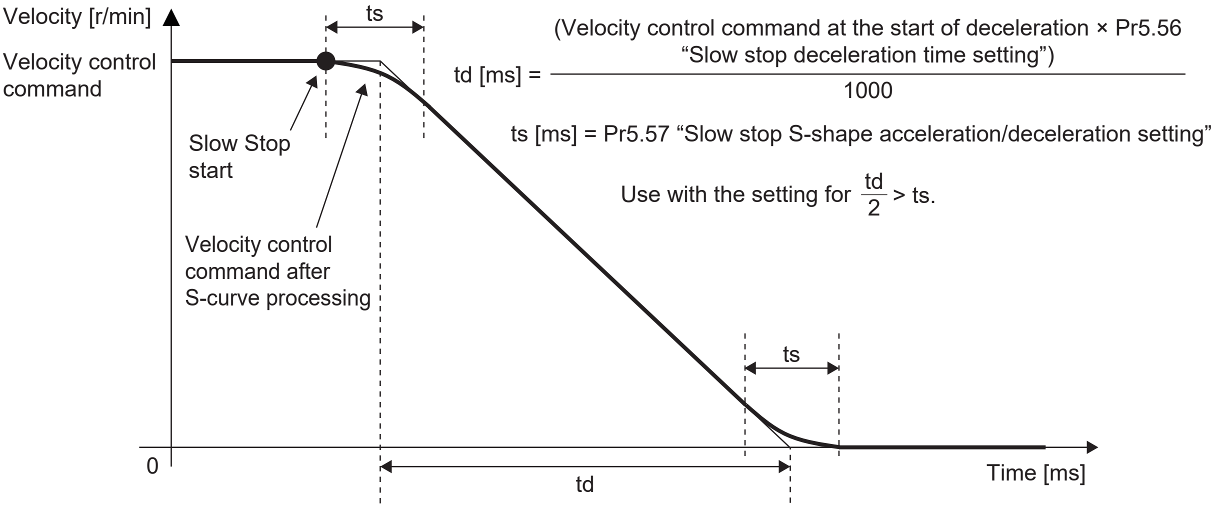
**— Precautions —**

- Please maintain the main circuit power supply until deceleration to stop.

- Slow Stop S-curve process

S-curve processing can be performed during Slow Stop operation by setting Pr5.57 “Slow stop S-shape acceleration and deceleration setting” .

See the figure below and set Pr5.57 “Slow stop S-shape acceleration and deceleration setting” .



$$\text{td [ms]} = \frac{\text{(Velocity control command at the start of deceleration} \times \text{Pr5.56 “Slow stop deceleration time setting”)}}{1000}$$

ts [ms] = Pr5.57 “Slow stop S-shape acceleration/deceleration setting”

Use with the setting for $\frac{td}{2} > ts$.

Velocity control command at the time of starting Slow Stop operation is calculated from the actual velocity.

- Braking distance

When Pr5.56 “Slow stop deceleration time setting” and Pr5.57 “Slow stop S-shape acceleration and deceleration setting” are set, the braking distance during an emergency stop increases approximately by the amount calculated using the formula below.

Please confirm the effect on actual machine operation before use.

- With linear deceleration (Pr5.57 = 0)

  Linear deceleration time [s]

$$= \frac{\text{Velocity control command at time deceleration begins [r/min]} \times \text{Pr5.56 [ms/(1000 r/min)]}}{1000 \times 1000}$$

  Linear deceleration braking distance [rotations]

$$= \frac{\text{Velocity control command at time deceleration begins [r/min]} \times \text{Linear deceleration time [s]}}{60 \times 2}$$

$$= \frac{(\text{Velocity control command at time deceleration begins [r/min]})\ 2 \times \text{Pr5.56 [ms/(1000 r/min)]}}{60 \times 2 \times 1000 \times 1000}$$

- With S-curve deceleration (Pr5.57 ≠ 0)

  S-curve deceleration braking distance [rotations]

$$= \text{Linear deceleration braking distance [rotations]} + \frac{\text{Velocity control command at time deceleration begins [r/min]} \times \text{Pr5.57 [ms]}}{60 \times 1000 \times 2}$$

**— Precautions —**

- The formulas above indicate braking distances for the velocity control command. In actual operation, motor control delay must be taken into account.

  Furthermore, if the torque command under deceleration is restricted by the torque setup for emergency stop, the braking distance may not be as per the formulas above.

## 8.20 Driver Derating Function

This function applies derating to the servo driver's overload protection time characteristic according to the derating scale factor set by the parameter.

### ■ Setup value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 5 | 110 | A | Driver derating factor | 0 to 100 | % | Sets the derating factor for servo driver overload protection time characteristics. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### ■ How to use

See “Derating Specifications” in *“2.1.4.1 Basic Specifications”* and set the driver derating factor according to the ambient operating conditions. The overload protection time characteristics of the servo driver vary depending on the derating factor. When the driver rated current ratio reaches the driver overload protection time characteristic, WngE1h “Driver overload warning” is triggered. At this time, the driver derating monitor is set to 100%. Check the driver derating monitor and adjust the operating conditions so that the servo driver overload protection time characteristics are not reached.

Check the following for the driver derating monitor.

- See *“3.4.3 7-Segment LED”* for details on the 7-segment LED.
- Monitor signal output For details, see *“3.2.8 Wiring to Connector X7 (Connecting to External Monitor)”* .
- Servo information monitoring objects For details, see *“6.6.8.7 Servo Information Monitoring Object”*
- Set-up Support Software (PANATERM ver.7) waveform measurement function driver derating monitor
- Set-up Support Software (PANATERM ver.7) monitor screen driver derating monitor

# 9 Safety Function

## 9.1 Safe Torque Off (STO) Function

### 9.1.1 Supported Standards

Details of supported standards are indicated below.

**Safety Parameters**

| Parameters | With SSU diagnostic | With EDM diagnostic | With neither EDM nor SSU diagnostic |
|---|---|---|---|
| Safety integrity level | EN 61508 (SIL3)<br>EN IEC 62061 (maximum SIL 3) | EN 61508 (SIL3)<br>EN IEC 62061 (maximum SIL 3) | EN 61508 (SIL2)<br>EN IEC 62061 (maximum SIL 2) |
| Performance level | EN ISO 13849-1:2015<br>Category 3 PL e | EN ISO 13849-1:2015<br>Category 3 PL e | EN ISO 13849-1:2015<br>Category 3 PL d |
| Safety function | EN 61800-5-2 (SIL 3, STO) | EN 61800-5-2 (SIL 3, STO) | EN 61800-5-2 (SIL 2, STO) |
| Probability of dangerous failure per unit of time | PFH=0.88 $\times 10^{-8}$ [1/h]<br>(% SIL3=8.8 %) | PFH=0.88 $\times 10^{-8}$ [1/h]<br>(% SIL3=8.8 %) | PFH=0.91$\times$ $10^{-8}$ [1/h]<br>(% SIL2=0.91 %) |
| Average time to dangerous failure | MTTFd: High (100 years) | MTTFd: High (100 years) | MTTFd: High (100 years) |
| Average self-diagnosis coverage | DC: Medium 94.6 [%] | DC: Medium 94.6 [%] | DC: Low 68.1 [%] |
| Mission time | 15 years | 15 years | 15 years |
| Stop category | IEC 60204-1 (stop category 0) | IEC 60204-1 (stop category 0) | IEC 60204-1 (stop category 0) |

For details about diagnostics via SSU and EDM, see *“9.1.4 STO Function Diagnostics”* .

When exporting, follow the statutory provisions of the destination country.

**— Precautions —**

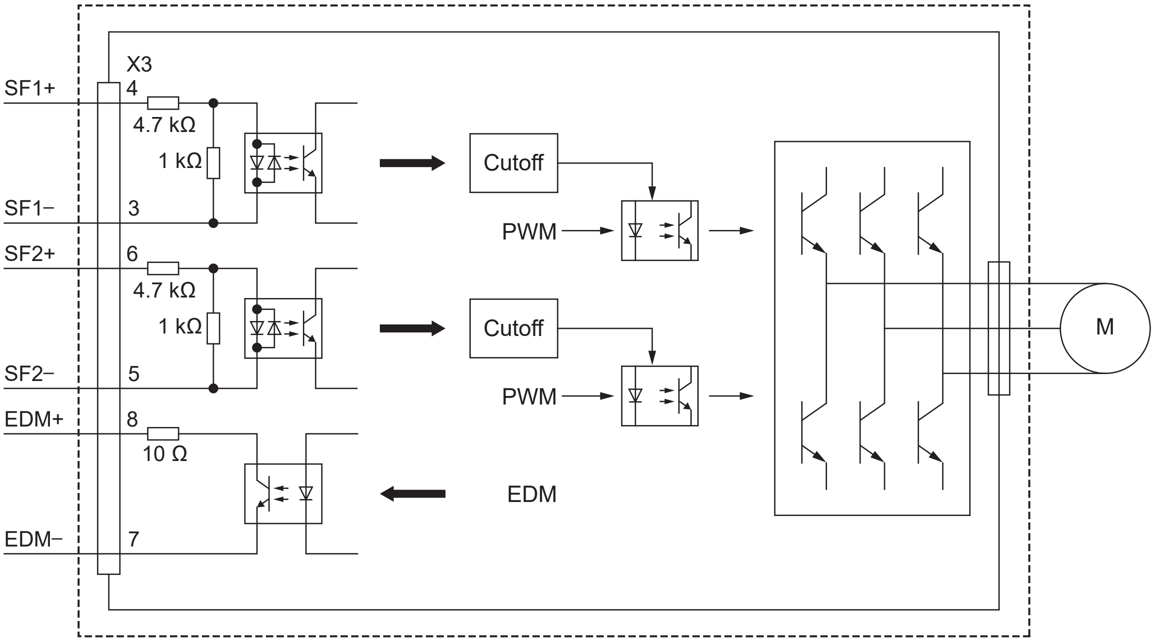
- The standard type does not support the functional safety standards.
- This product is not subject to China Compulsory Certification (CCC).

### 9.1.2 Operation Overview

This function turns off the motor output torque by forcibly turning off the driving signal of the power transistor inside the servo driver from the safety input signal by means of an electric circuit (hardware), thereby cutting off the motor current.

The servo driver's internal power transistor driving signal, which controls the motor current, is forcibly turned off by a safety input signal.

The STO function is compliant with stop category 0 of IEC 60204-1.



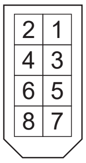
SF1 +, SF1 − : Safety input 1 signal
SF2 +, SF2 − : Safety input 2 signal
EDM +, EDM − : External device monitor (EDM) output signal

## 9.1.3 Input and Output Signals

1 Safety function connector (connector X3) specifications

The safety function connector (connector X3) specifications are indicated below.

**Pinout diagram**



| Signal name | Symbol | Connector pin no. | Description |
|---|---|---|---|
| — | — | 1 | This terminal is for the safety bypass, so do not connect anything other than the safety bypass plug. |
| | — | 2 | |
| Safety input 1 | SF1- | 3 | ● Input 1 for operating the STO function. This input interrupts the power transistor upper arm driving signal.<br>● Make sure that it is connected so that the input circuit photocoupler turns OFF when the STO function is activated. |
| | SF1+ | 4 | |
| Safety input 2 | SF2- | 5 | ● Input 2 for operating the STO function. This input interrupts the power transistor lower arm driving signal.<br>● Make sure that it is connected so that the input circuit photocoupler turns OFF when the STO function is activated. |
| | SF2+ | 6 | |
| EDM output | EDM- | 7 | This is a monitoring output for monitoring safety function failures.<br>Do not use this monitor output when using the SSU function. |
| | EDM+ | 8 | |
| Frame ground | FG | Shell | Connected to the earth terminal inside the servo driver. |

2 Input signal

The STO function compatible servo driver types have two safety input circuit channels for the STO function.

- In the case of both safety inputs 1 and 2, the STO function operates within 5 ms after input, and the motor output torque is turned off.
- Input the same signal for both safety inputs 1 and 2.

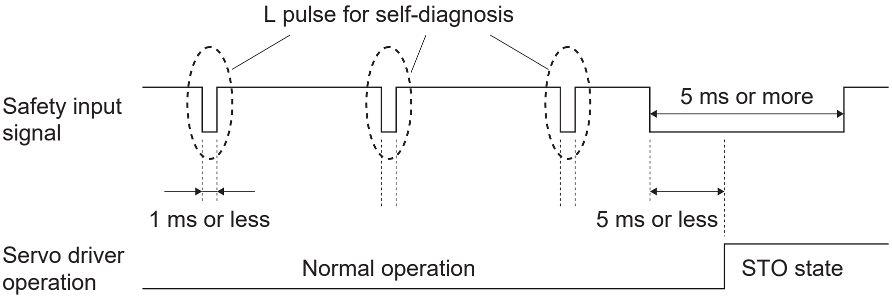
**— Precautions —**

- Safety equipment L pulse for self-diagnosis

  When safety sensors and other safety devices are connected, their safety output signals (i.e. safety input signals to the servo driver) may include an L pulse for self-diagnosis.

  To prevent the L pulse from erroneously triggering the STO function, the safety input circuit has a built-in filter that removes the self-diagnosis L pulse.

  As such, the safety input circuit will not recognize safety input signal OFF time of 1 ms or less as OFF. Let the safety input signal remain OFF for 5 ms or more in order to enable the safety input circuit to reliably recognize that it is OFF.



3 Output signal

The STO function-supporting types of servo driver are provided with external device monitor output (EDM output) for monitoring safety input signal status, using an external device.

Be sure to connect the servo driver EDM output signal to the external device monitor terminals of safety sensors and other safety devices.

Do not use EDM output when using the STO Signal Unmatch (SSU) function.

For more information on the SSU function, see *"9.1.4 STO Function Diagnostics"* ("2" Diagnostics via SSU (STO Signal Unmatch) function).

4 Logical relationship between safety input signal and EDM output signal

EDM outputs corresponding to ON/OFF of safety inputs 1 and 2 during normal operation indicate the ON/OFF status.

When both safety inputs 1 and 2 (SF1, SF2) are OFF, i.e. when the safety input indicates that the STO function safety input is operating in both channels, the photocoupler in the EDM output circuit turns ON.

| Signal name | Symbol | Photocoupler logic | | | |
|---|---|---|---|---|---|
| Safety input | SF1 | ON | ON | OFF | OFF |
| | SF2 | ON | OFF | ON | OFF |
| EDM output | EDM | OFF | OFF | OFF | ON |

Monitoring the abovementioned photocoupler logic (in all four statuses) via an external device enables detection of malfunctions in the safety input circuit and EDM output circuit.

In the event of an error, the following conditions are detected.

- The photocoupler of the EDM output circuit turns ON even though both safety inputs 1 and 2 (SF1 and SF2) are ON.
- The photocoupler of the EDM output circuit turns ON even though one of the safety inputs 1 and 2 (SF1 and SF2) is turned on.
- The photocoupler in the EDM output circuit does not turn ON even though both safety inputs 1 and 2 (SF1 and SF2) are OFF.

The maximum delay time from input of safety input 1 and 2 signals to output of the EDM output signal is 6 ms.

## 9.1.4 STO Function Diagnostics

In order to achieve the safety levels SIL3 and PL e, EDM output, and the SSU function is needed for STO function diagnosis (maximum diagnosis interval is 3 months). Safety levels are SIL 2 and PL d when no STO function diagnosis is performed.

1 Diagnostics via EDM output

Switch OFF safety input 1 and safety input 2 for at least 6 ms, monitor the EDM output signal and check that it is in accordance with the photocoupler logic chart given above.

2 Diagnostics via SSU (STO Signal Unmatch)

The SSU function detects errors within the internal circuits of safety input 1 and safety input 2. Switch OFF safety input 1 and safety input 2 for at least 10 s, and confirm that no error occurs.

When diagnosing, if a safety input signal SF1 or SF2 logic error persists for longer than 10 seconds, the diagnostic result will generate Err31.0.12 “Safety function error protection 1”.

**Notes**

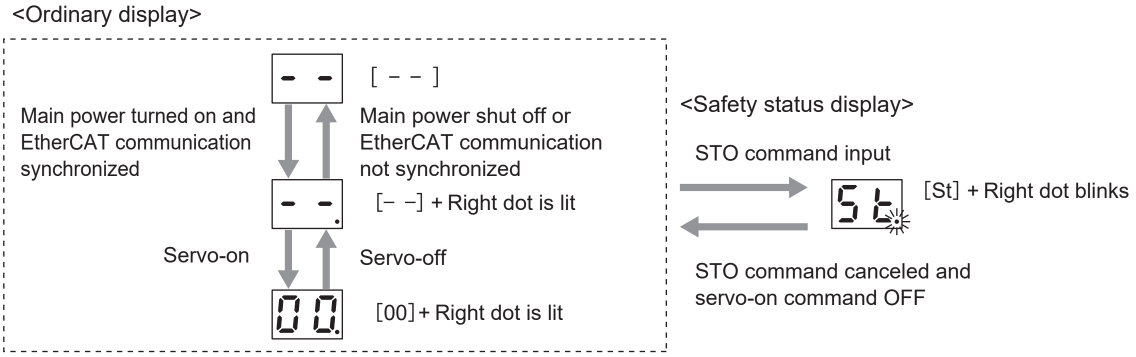
- Diagnostics via the SSU function do not use EDM output signals, so the EDM output signal does not need to be monitored using an external device.

### 9.1.5 Operation

When the STO function operates, the servo-ready output signal (S-RDY) of the servo driver is turned off, and is in STO status.

When in STO status, the servo driver is not in alarm status.

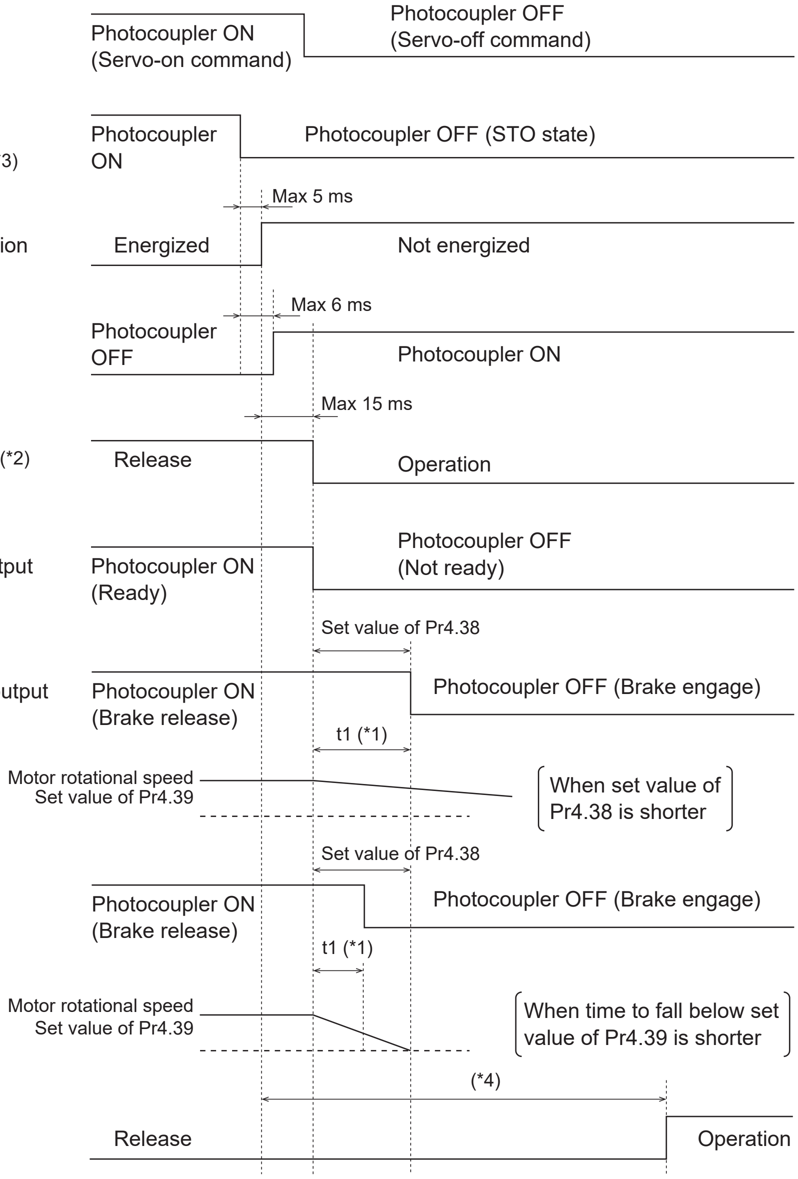
“St” is displayed on the 7-segment LED on the front panel.



After STO status transition, STO input is canceled, and when the servo-on input is turned OFF (servo-off command), STO status is canceled, and automatically transitions to servo ready status.

The operation timings during the transition to STO status and during return from STO status are shown below.

### 1 Figure of operation timing during the transition to “STO status”



*1 The time (t1) from the time that the servo-ready output (S-RDY) changed from ON (ready status) to OFF (not-ready status), and from release of mechanical braking until the changeover to operation, is shorter than the time until the value falls below the value set for Pr4.38 “Mechanical brake action at running setup” or the motor rotational speed falls below Pr4.39 “Brake release speed setup” .

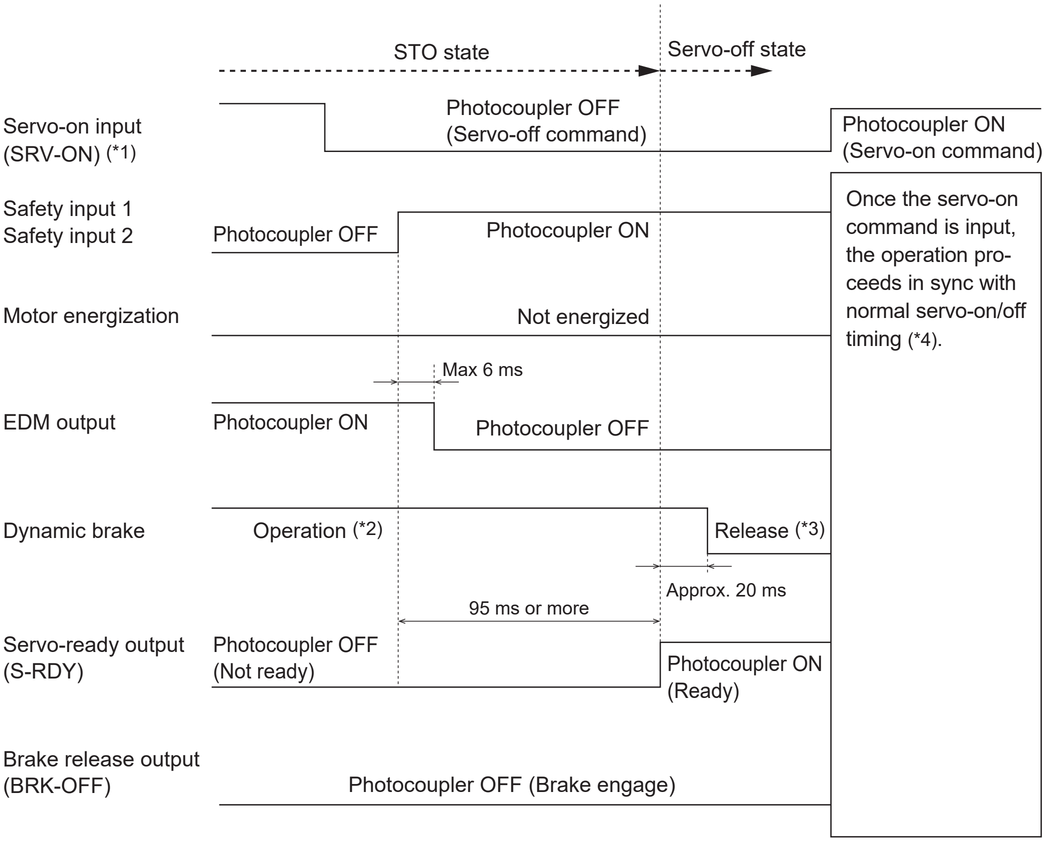
*2 Dynamic brake operation follows the setting of Pr5.10 “Sequence at alarm” .

(“Sequence at alarm” is also applicable even if there is no alarm in STO status.)

*3 Turn OFF safety inputs 1 and 2 simultaneously when the STO function is used.

*4 There is a drop on the vertical axis, since servo lock is not possible during the interval from the time the motor power is turned off until the external brake operates. Ensure that this does not pose a problem.

## 2 Figure of operation timing during the return from “STO status”



*1 When photocouplers for safety input 1 and 2 are returned to ON, be sure to perform the operation with servo-on input turned OFF. When photocouplers for safety input 1 and 2 are returned to ON, servo ready status is automatically restored. Nor is there any need to clear an alarm.

*2 Due to STO status during dynamic brake operation, dynamic brake setting follows Pr5.10 “Sequence at alarm” .

(The “sequence at alarm” is applicable even if there is no alarm.)

*3 Since it is in servo-off during dynamic brake release, the dynamic brake setting follows Pr5.06 “Sequence at servo-off” .

*4 *“7.1 Startup Operation”* Please see the timing chart given in *“Operation”* .

### 9.1.6 Example Connection

The following shows an example of safety device connection to a servo driver.

**— Precautions —**

- Depending on the safety device connected, it may be necessary to turn the servo driver power on first.

  In this case, the servo driver is in STO status.

  The method of return from STO status is as follows.

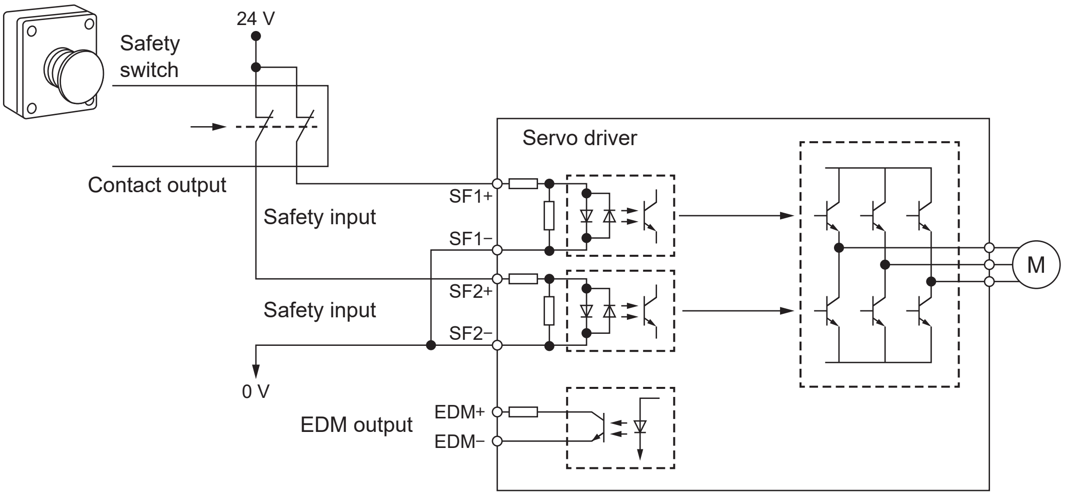
  1 Turn OFF the servo-on command.

  2 The photocouplers for safety input 1 and 2 are returned to ON.

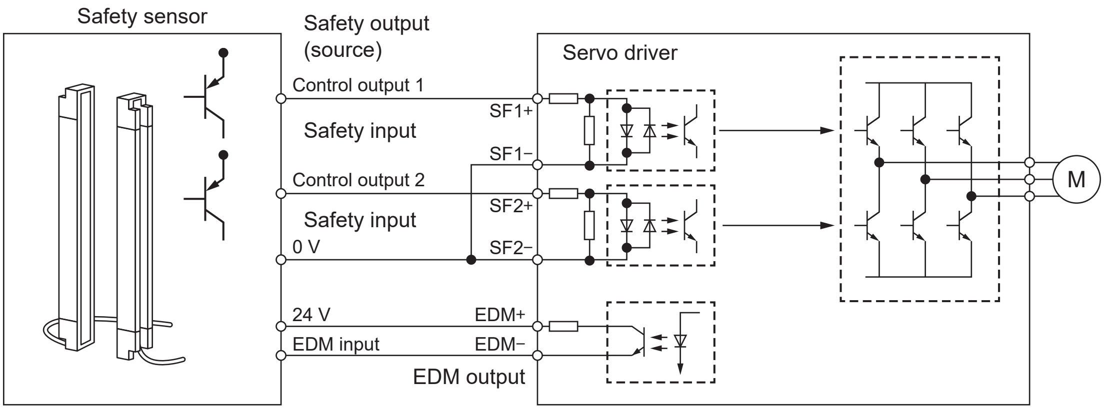
  3 There is an automatic return to servo ready status.

  For details, see *"9.1.5 Operation"* (Diagram of operation timing during the return from "2" "STO status").

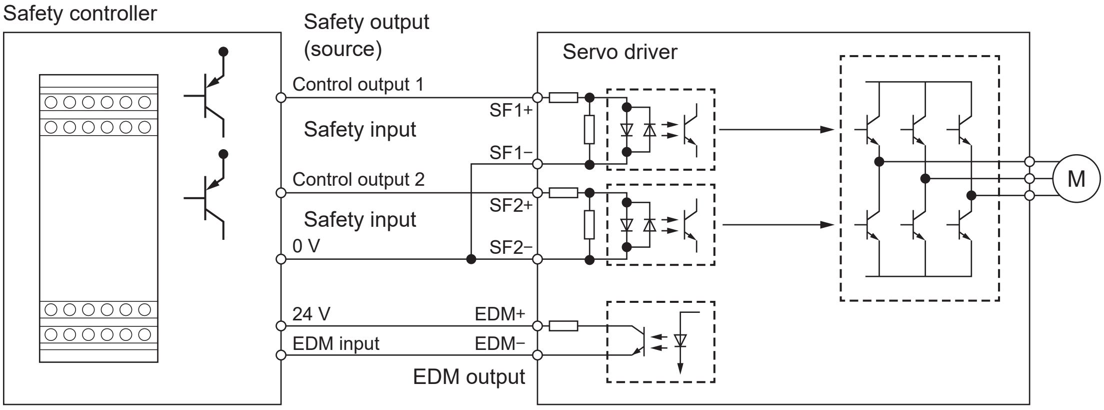
1 **Example of connection to a safety switch**



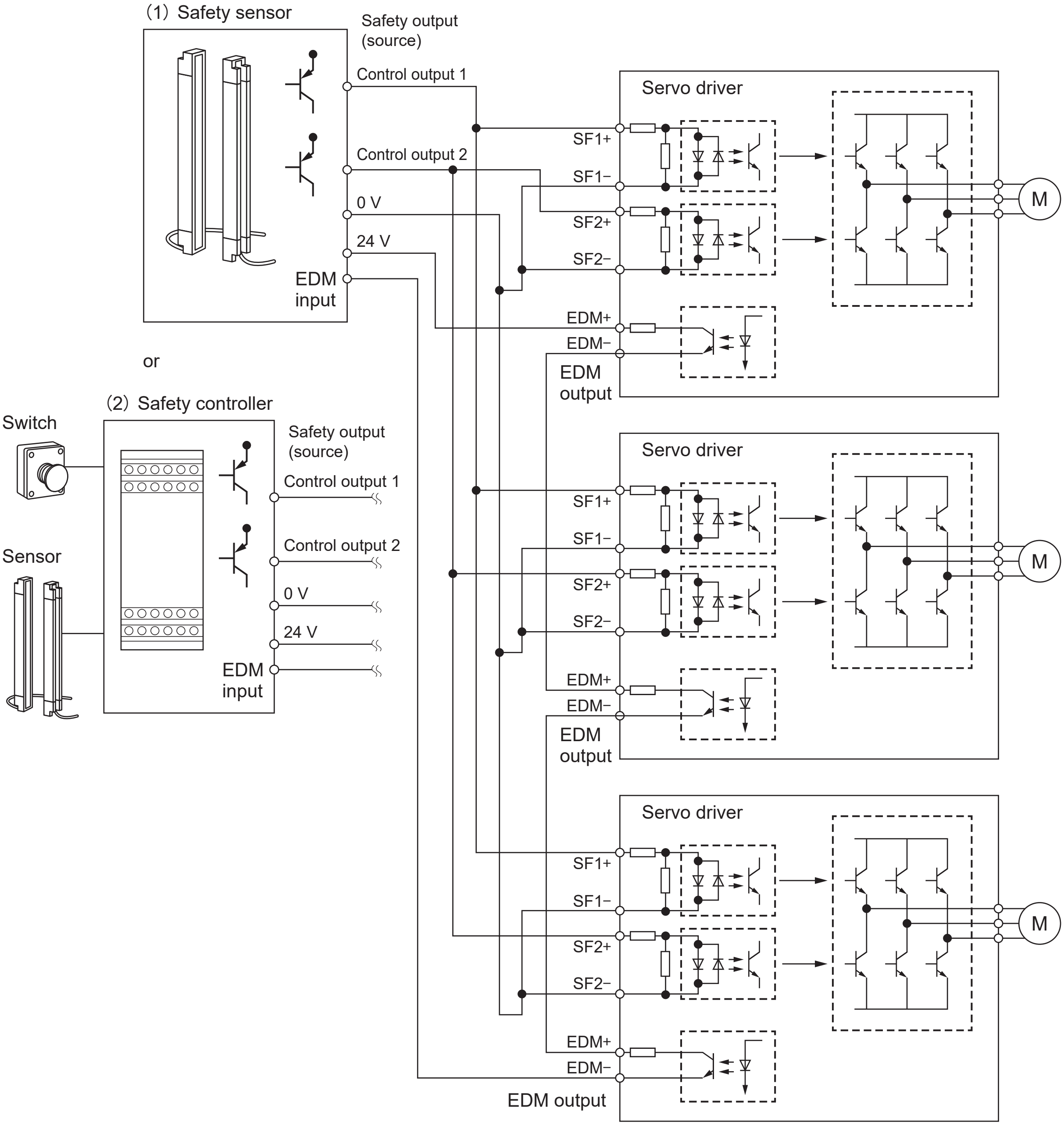
2 **Example of connection to a safety sensor**



## 3 Example of connection to a safety controller



## 4 Example of connection when using multiple axes



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*1 The maximum number of axes connectible is a reference value.

The maximum number of axes connectible is limited, since the collector saturation voltage $V_{ce}$ (sat) of the built-in photocoupler is approximately 1 when EDM outputs are serially connected. Moreover, this $V_{ce}$ (sat) varies depending on the collector current.

Since approximately 6.1 mA per circuit flows to the SF inputs, the current is increased proportionally as the number of axes connected increases. The number of axes connected must be limited so as not to exceed the maximum output current on the safety device side.

* Required current capacity per safety output (source) channel: the number of connected axes × 6.1 (mA)

* 24 V DC allowable power supply voltage: 24 V ± 15%

* Maximum number of axes connectible: 8 axes

### 9.1.7 Safety Precautions

- When using the STO function, be sure to confirm that the system satisfies safety requirements by conducting a risk assessment of the device.

  Use without fulfilling safety requirements may lead to personal injury, depending on the circumstances.
- Always take safety into account during risk assessment, since there are the following risks, even when the STO function is operating.

  Incorrect use may lead to personal injury, depending on the circumstances.
  - Devise means such as an external brake, etc., as necessary to secure the motor, since the motor may move when external force (e.g. gravity on the vertical axis) is exerted on it. Also note that the servo motor with brake is only for holding, and cannot be used for braking purposes.
  - When Pr5.10 “Sequence at alarm” is set to free run (and dynamic brake is disabled), the motor is in free run status, and requires a longer stop distance even if no external force is applied. Ensure that this does not pose a problem.

    (The “deceleration to stop at alarm” is also applicable in STO status, even if there is no alarm.)
  - A malfunctioning power transistor, etc. may cause the motor to move by an electrical angle of approximately 180 degrees. Ensure that this does not pose a problem.
  - Power to the motor is turned off by the STO function, but power to the servo driver is not turned off, and it is not electrically insulated. Devise means such as separately turning off power to a servo driver during servo driver maintenance, etc.
- The EDM output signal is not safety output. Do not use for other purposes than as a malfunction monitoring function.

  Incorrect use may lead to personal injury, depending on the circumstances.
- STO (Safe Torque Off) status monitor output signal is not a safety-related part. In system design, confirm no risks will be present when the STO status monitor output signal cannot output normally.

  Incorrect use may lead to personal injury, depending on the circumstances.
- The dynamic brake and external brake release signal output are not safety-related features. In system design, confirm that malfunctioning external brake release will not present a risk during STO status.

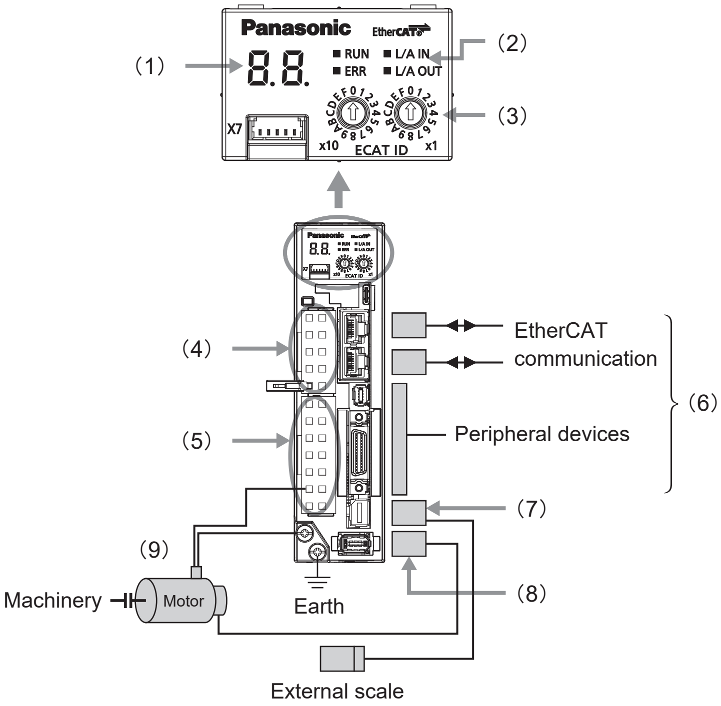
  Incorrect use may lead to personal injury, depending on the circumstances.
- Only connect devices that are compliant with safety standards when using the STO function.

  Use of devices that are not compliant with safety standards may lead to personal injury, depending on the circumstances.

# 10 Protection Function, Warning Function, Time Stamp Function

## 10.1 Where to Check

The places to check and a description of items that should be checked when there is trouble or an error is generated are shown below.



| No. | Where to check | What to check |
|---|---|---|
| (1) | 7-Segment LED | Does an error number appear? |
| (2) | EtherCAT Indicators | Are both the L/A IN and L/A OUT indicators lit green?<br>For details, see *"3.4.4 EtherCAT Indicators"* . |
| (3) | Station Alias (ID) setting rotary switch | Is there a mistake in the Station Alias (ID) or parameter settings?<br>For details, see *"3.4.2 Node Address"* . |
| (4) | Connector XA | Has the power supply voltage changed?<br>Is power being input?<br>Is there a loose connection? |
| (5) | Connector XB | Has the connector been disconnected? (Broken wire, contact)<br>Is the connector wiring correct?<br>Has the connector been removed?<br>Has the short wire been removed? |
| (6) | Connectors X2, X3, X4 | Is the connector wiring correct?<br>Is a connector disconnected? |
| (7) | Connector X5 | In the case of full-closed control, is the connector wiring correct?<br>Is a connector disconnected? |
| (8) | Connector X6 | Is the connector wiring correct?<br>Is a connector disconnected? |
| (9) | Motor | Is there an abnormal noise coming from the motor?<br>Is the holding brake engaged?<br>Is the connection loose? |

## 10.2 Protection Functions

Protection functions ensure safety by stopping the motor when errors are detected in the equipment.

Protection functions are assigned alarm numbers beginning with “Err”.

Alarm numbers are divided into main numbers, sub-numbers, and cause numbers.

For example, in the case of Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)” , the main number is 13, the sub-number is 1, and the cause number is 0.

### 10.2.1 Operation

- Operation when a protection function is triggered

  Various types of protection function are built into this product and constantly monitor the operating state of the device.

  If an equipment error is detected and the protection function is triggered, the motor of this product is stopped and put into an alarm state and the alarm output signal (ALM) is turned off.

  When the alarm is triggered, an alarm number is displayed in the 7-segment LED on the front panel.

  For an example of alarm number display, see *“3.4.3 7-Segment LED”* .

  In addition, alarms related to EtherCAT communication (Err80.☐.☐, Err81.☐.☐, Err85.☐.☐, Err88.☐.☐), the Set-up Support Software (PANATERM ver.7) alarm indication on the 7-segment LED display on the front panel is displayed later than the actual alarm occurrence.

- Clearing alarms

  There are two types of alarms triggered by the protection function: alarms that support alarm clearing and alarms that do not support alarm clearing. For the alarm clear attribute, see *“10.2.2 List of Protection Functions”* .

  The product offers the following three alarm clearing methods. Among the alarms that support alarm clear, if EtherCAT communication-related (Err80.☐.☐, Err81.☐.☐, Err85.☐.☐, Err88.☐.☐) is triggered, clear the alarm by the method “2” or “3”. Be sure to clear an alarm while the equipment is stopped, after confirming it is safe. For details on clearing alarms, see Technical Reference Communication Specification “6.1.4 Clearing Alarms, Clearing Warnings” .

  1 Clearing alarms with AL Control
  2 Clearing alarms with Set-up Support Software (PANATERM ver.7)
  3 Clearing alarms with external alarm clear input (A-CLR)

  When an alarm that does not support alarm clearing is generated, once the source of the alarm has been eliminated, shut off and then reset the control power.

## 10.2.2 List of Protection Functions

A list of protection functions is shown below.

○: Supported ×: Not supported -: N/A

| Alarm number | | | Alarm name | Attribute | | | ERR indicator display (*4) | ESC register AL status code (*5) |
|---|---|---|---|---|---|---|---|---|
| Main | Sub | Primary cause | | History (*2) | Alarm clear | Emergency stop (*3) | | |
| 11 | 0 | 0 | Control power supply undervoltage protection | × | ○ | × | OFF | 0000h |
| 12 | 0 | 0 | Overvoltage protection | ○ | ○ | × | OFF | 0000h |
| 13 | 0 | 0 to 1 | Main power supply undervoltage protection (voltage across PN) | × | ○ | ○ | OFF | 0000h |
| | 1 | 0 | Main power supply undervoltage protection (AC interrupt detection) | × | ○ | ○ | OFF | 0000h |
| | 2 | 0 | Main power supply phase loss protection (AC interception detection) | × | ○ | ○ | OFF | 0000h |
| 14 | 0 | 0 | Overcurrent protection 1 | ○ | × | × | OFF | 0000h |
| | 1 | 0 | Overcurrent protection 2 | ○ | × | × | OFF | 0000h |
| | | 1 | Overheat protection 2 | ○ | × | × | OFF | 0000h |
| | | 2 | Overheat protection 3 | ○ | × | × | OFF | 0000h |
| 15 | 0 | 0 | Overheat protection 1 | ○ | × | ○ | OFF | 0000h |
| | 1 | 0 | Encoder overheat error protection | ○ | × | ○ | OFF | 0000h |
| 16 | 0 | 0 | Overload protection | ○ | ○ (*6) | × | OFF | 0000h |
| | 1 | 0 | Torque saturation error protection | ○ | ○ | × | OFF | 0000h |
| 18 | 0 | 0 | Regenerative overload protection | ○ | × | ○ | OFF | 0000h |
| | 1 | 0 | Regenerative transistor error protection | ○ | × | × | OFF | 0000h |
| 21 | 0 | 0 to 1<br>90 | Encoder communication disconnection error protection | ○ | × | × | OFF | 0000h |
| | 1 | 0 to 3 | Encoder communication error protection | ○ | × | × | OFF | 0000h |
| 23 | 0 | 0 | Encoder communication data error protection | ○ | × | × | OFF | 0000h |
| 24 | 0 | 0 | Position deviation excess protection | ○ | ○ | ○ | OFF | 0000h |
| | 1 | 0 | Speed deviation excess protection | ○ | ○ | ○ | OFF | 0000h |
| 25 | 0 | 0 | Hybrid deviation excess protection | ○ | × | ○ | OFF | 0000h |
| 26 | 0 | 0 | Overspeed protection | ○ | ○ | ○ | OFF | 0000h |
| | 1 | 0 | 2nd Overspeed protection | ○ | ○ | × | OFF | 0000h |
| 27 | 1 | 0 | Absolute clear protection | ○ | × | × | OFF | 0000h |
| | 4 | 0 | Position command error protection | ○ | ○ | ○ | OFF | 0000h |

| Alarm number | | | Alarm name | Attribute | | | ERR indicator display (*4) | ESC register AL status code (*5) |
|---|---|---|---|---|---|---|---|---|
| Main | Sub | Primary cause | | History (*2) | Alarm clear | Emergency stop (*3) | | |
| 27 | 5 | 0 | Command generation error protection | ○ | × | ○ | OFF | 0000h |
| | 6 | 0 to 1 | Operation command contention protection | ○ | ○ | × | OFF | 0000h |
| | 7 | 0 | Position information initialization error protection | ○ | × | × | OFF | 0000h |
| 28 | 0 | 0 | Pulse regeneration limit protection | ○ | ○ | ○ | OFF | 0000h |
| 29 | 1 | 0 | Counter overflow protection 1 | ○ | × | × | OFF | 0000h |
| | 2 | 0 to 5 | Counter overflow protection 2 | ○ | × | × | OFF | 0000h |
| 31 | 0 | 0 to 2<br>10 to 12<br>20 to 25<br>30 to 37<br>40 to 43 | Safety function error protection 1 | ○ | × | × | OFF | 0000h |
| | 2 | 0 to 3 | Safety function error protection 2 | ○ | × | × | OFF | OFF |
| 33 | 0 | 0 | Input overlapping assignment error 1 protection | ○ | × | × | OFF | 0000h |
| | 1 | 0 | Input overlapping assignment error 2 protection | ○ | × | × | OFF | 0000h |
| | 2 | 0 | Input function number error 1 protection | ○ | × | × | OFF | 0000h |
| | 3 | 0 | Input function number error 2 protection | ○ | × | × | OFF | 0000h |
| | 4 | 0 | Output function number error 1 protection | ○ | × | × | OFF | 0000h |
| | 5 | 0 | Output function number error 2 protection | ○ | × | × | OFF | 0000h |
| | 8 | 0 | Latch input assignment error protection | ○ | × | × | OFF | 0000h |
| 34 | 0 | 0 | Motor movable range setup error protection | ○ | ○ | × | OFF | 0000h |
| | 1 | 0 | Single-turn absolute movable range error protection | ○ | ○ | × | OFF | 0000h |
| 36 | 0 to 1 | 0 | EEPROM parameter error protection | × | × | × | OFF | 0000h |
| 37 | 0 to 2 | 0 | EEPROM check code error protection | × | × | × | OFF | 0000h |
| 38 | 0 | 0 | Over-travel inhibit input protection 1 | × | ○ | × | OFF | 0000h |
| | 1 | 0 | Over-travel inhibit input protection 2 | × | ○ | × | OFF | 0000h |
| | 2 | 0 | Over-travel inhibit input protection 3 | ○ | × | × | OFF | 0000h |
| 39 | 0 | 0 | Analog input (AIN) excess protection | ○ | ○ | ○ | OFF | 0000h |

| Alarm number | | | Alarm name | Attribute | | | ERR indicator display (*4) | ESC register AL status code (*5) |
|---|---|---|---|---|---|---|---|---|
| Main | Sub | Primary cause | | History (*2) | Alarm clear | Emergency stop (*3) | | |
| 40 | 0 | 0 | Absolute system down error protection | ○ | ○ (*7) | × | OFF | 0000h |
| 41 | 0 | 0 | Absolute counter over error protection | ○ | × | × | OFF | 0000h |
| 42 | 0 | 0 | Absolute overspeed error protection | ○ | ○ (*7) | × | OFF | 0000h |
| 44 | 0 | 0 | Single-turn counter error protection | ○ | × | × | OFF | 0000h |
| 45 | 0 | 0 | Multi-turn counter error protection | ○ | × | × | OFF | 0000h |
| 47 | 0 | 0 | Absolute status error protection | ○ | × | × | OFF | 0000h |
| 50 | 0 | 0 | External scale wiring error protection | ○ | × | × | OFF | 0000h |
| | 1 | 0 to 2 | External scale communication error protection | ○ | × | × | OFF | 0000h |
| | 2 | 0 | External scale communication data error protection | ○ | × | × | OFF | 0000h |
| 51 | 0 | 0 | External scale status error protection 0 | ○ | × | × | OFF | 0000h |
| | 1 | 0 | External scale status error protection 1 | ○ | × | × | OFF | 0000h |
| | 2 | 0 | External scale status error protection 2 | ○ | × | × | OFF | 0000h |
| | 3 | 0 | External scale status error protection 3 | ○ | × | × | OFF | 0000h |
| | 4 | 0 | External scale status error protection 4 | ○ | × | × | OFF | 0000h |
| | 5 | 0 | External scale status error protection 5 | ○ | × | × | OFF | 0000h |
| 55 | 0 | 0 | A-phase connection error protection | ○ | × | × | OFF | 0000h |
| | 1 | 0 | B-phase connection error protection | ○ | × | × | OFF | 0000h |
| | 2 | 0 | Z-phase connection error protection | ○ | × | × | OFF | 0000h |
| 68 | 0 | 0 | Internal communication processing error protection1 | ○ | × | × | OFF | 0000h |
| | 3 | 0 to 3 | Internal communication processing error protection4 | ○ | × | × | OFF | 0000h |
| | 5 | 0 | Internal communication processing error protection6 | ○ | × | × | OFF | 0000h |
| | 6 | 0 | Internal communication processing error protection7 | ○ | × | × | OFF | 0000h |
| | 7 | 0 | Internal communication processing error protection8 | ○ | × | × | OFF | 0000h |
| | 8 | 0 | Internal communication processing error protection9 | ○ | × | × | OFF | 0000h |
| | 9 | 0 | Internal communication processing error protection10 | ○ | × | × | OFF | 0000h |

| Alarm number | | | Alarm name | Attribute | | | ERR indicator display (*4) | ESC register AL status code (*5) |
|---|---|---|---|---|---|---|---|---|
| Main | Sub | Primary cause | | History (*2) | Alarm clear | Emergency stop (*3) | | |
| 68 | 10 | 0 | Internal communication processing error protection11 | ○ | × | × | OFF | 0000h |
| | 11 | 0 | Internal communication processing error protection12 | ○ | × | × | OFF | 0000h |
| | 14 | 0 | Internal communication processing error protection15 | ○ | × | × | OFF | 0000h |
| | 19 | 0 | Internal communication processing error protection20 | ○ | × | × | OFF | 0000h |
| | 21 | 0 | Internal communication processing error protection22 | ○ | × | × | OFF | 0000h |
| 70 | 0 | 0 | U-phase current detector error protection 1 | ○ | × | × | OFF | 0000h |
| | | 1 | U-phase current detector error protection 2 | ○ | × | × | OFF | 0000h |
| | 1 | 0 | W-phase current detector error protection 1 | ○ | × | × | OFF | 0000h |
| | | 1 | W-phase current detector error protection 2 | ○ | × | × | OFF | 0000h |
| 72 | 0 | 0 | Thermal error protection | ○ | × | × | OFF | 0000h |
| 75 | 0 | 0 to 1 | External memory access error protection | ○ | × | × | OFF | 0000h |
| 77 | 0 | 0 | Microcomputer error protection 1 | ○ | × | × | OFF | 0000h |
| | 2 | 0 | Microcomputer error protection 3 | ○ | × | × | OFF | 0000h |
| | 6 | 0 to 3 | Microcomputer error protection7 | ○ | × | × | OFF | 0000h |
| 80 | 0 | 0 | ESM unauthorized request error protection | ○ | ○ | ○ | Blinking | 0011h |
| | 1 | 0 | ESM undefined request error protection | ○ | ○ | ○ | Blinking | 0012h |
| | 2 | 0 | Bootstrap requests error protection | ○ | ○ | × | Blinking | 0013h |
| | 3 | 0 | Incomplete PLL error protection | ○ | ○ | × | Single flash | 002Dh |
| | 4 | 0 | PDO watchdog error protection | ○ | ○ | ○ | Double flash | 001Bh |
| | 6 | 0 | PLL error protection | ○ | ○ | ○ | Single flash | 0032h |
| | 7 | 0 | Synchronization signal error protection | ○ | ○ | ○ | Single flash | 002Ch |
| 81 | 0 | 0 | Synchronization cycle error protection | ○ | ○ | × | Blinking | 0035h |
| | 1 | 0 | Mailbox error protection | ○ | ○ | × | Blinking | 0016h |
| | 4 | 0 | PDO watchdog setup error protection | ○ | ○ | × | Blinking | 001Fh |
| | 5 | 0 | DC error protection | ○ | ○ | × | Blinking | 0030h |
| | 6 | 0 | SM event mode error protection | ○ | ○ | × | Blinking | 0028h |
| | 7 | 0 | SyncManager 2 / 3 setup error protection | ○ | ○ | × | Blinking | 001Dh<br>001Eh |
| 84 | 3 | 0 | Initialization of synchronization establishment error protection | ○ | × | × | OFF | 0000h |

| Alarm number | | | Alarm name | Attribute | | | ERR indicator display (*4) | ESC register AL status code (*5) |
|---|---|---|---|---|---|---|---|---|
| Main | Sub | Primary cause | | History (*2) | Alarm clear | Emergency stop (*3) | | |
| 85 | 0 | 0 | TxPDO assignment error protection | ○ | ○ | × | Blinking | 0024h |
| | 1 | 0 | RxPDO assignment error protection | ○ | ○ | × | Blinking | 0025h |
| | 2 | 0 | Lost link error protection | ○ | ○ | ○ | Double flash | 0000h |
| | 3 | 0 | SII EEPROM error protection | ○ | × | × | Flickering | 0051h |
| 87 | 0 | 0 | Forced alarm input protection | × | ○ | ○ | OFF | 0000h |
| | 1 | 0 | Retracting operation completion (I/O) | ○ | (*8) | ○ (*9) | OFF | 0000h |
| | 2 | 0 | Retracting operation completion (communication) | ○ | (*8) | ○ (*9) | OFF | 0000h |
| | 3 | 0 to 6 | Retracting operation error | ○ | (*8) | ○ | OFF | 0000h |
| 88 | 0 | 0 | Main power supply undervoltage protection (AC interrupt detection 2) | × | ○ | ○ | OFF | 0000h |
| | 1 | 0 | Control mode setting error protection | ○ | ○ | ○ | OFF | 0000h |
| | 2 | 0 | ESM requirements during operation error protection | ○ | ○ | ○ | OFF | 0000h |
| | 3 | 0 | Improper operation error protection | ○ | × | ○ | OFF | 0000h |
| 91 | 1 | 0 | Command error protection | ○ | ○ | × | OFF | 0000h |
| 92 | 0 | 0 | Encoder data recovery error protection | ○ | × | × | OFF | 0000h |
| | 1 | 0 | External scale data recovery error protection | ○ | × | × | OFF | 0000h |
| | 3 | 0 to 2 | Multi-turn data upper limit value disagreement error protection | ○ | × | × | OFF | 0000h |
| 93 | 2 | 0 | Parameter setup error protection 2 | ○ | × | × | OFF | 0000h |
| | 3 | 0 to 5 | External scale connection error protection | ○ | × | × | OFF | 0000h |
| | 5 | 0 | Parameter setup error protection 4 | ○ | × | × | OFF | 0000h |
| | 8 | 0 | Parameter setup error protection 6 | ○ | × | × | OFF | 0000h |
| 94 | 3 | 0 | Homing error protection 2 | ○ | ○ | × | OFF | 0000h |
| 95 | 0 | 0 | Motor automatic recognition error protection 1 | × | × | × | OFF | 0000h |
| | 1 | 0 | Motor automatic recognition error protection 2 | × | × | × | OFF | 0000h |
| | 2 | 0 | Motor automatic recognition error protection 3 | × | × | × | OFF | 0000h |
| | 3 | 0 | Motor automatic recognition error protection 4 | × | × | × | OFF | 0000h |
| | 4 | 0 | Motor automatic recognition error protection 5 | × | × | × | OFF | 0000h |
| | 5 | 0 | Motor automatic recognition error protection 6 | × | × | × | OFF | 0000h |

| Alarm number | | | Alarm name | Attribute | | | ERR indicator display (*4) | ESC register AL status code (*5) |
|---|---|---|---|---|---|---|---|---|
| Main | Sub | Primary cause | | History (*2) | Alarm clear | Emergency stop (*3) | | |
| 96 | 4 | 0 | Host controller error protection 3 | ○ | × | × | OFF | 0000h |
| | 6 | 0 | Host controller error protection 5 | ○ | × | × | OFF | 0000h |
| 98 | 2 | 0 | Communication hardware error protection 2 | ○ | × | × | OFF | 0000h |
| | 3 | 0 | Communication hardware error protection 3 | ○ | × | × | OFF | 0000h |
| | 5 | 0 | Hardware self-diagnostic error protection 1 | × | × | × | OFF | 0000h |
| Other numbers | | | Other error protection | – | – | – | – | – |
| Special 7-segment display  | | | System error protection | × | × | × | OFF | 0000h |

*1 The alarm number is displayed in the 7-segment LED when the alarm is generated.

For details on 7-segment LED operation when an alarm is generated, see *"3.4.3 7-Segment LED"* .

*2 Alarms that support history (○) are stored in Sub-Index 06h to 23h "Diagnosis message 1 to 30" of Obj.10F3h: "Diagnosis history" when triggered.

*3 When a supported (○) emergency stop alarm triggers, an emergency stop will be performed if 4 to 7 is set in Pr5.10 "Sequence at alarm" . For details, see *"8.15 Deceleration to Stop Function for When Alarm is Triggered"* .

*4 ERR Indicator refers to the alarm status defined by the AL status code.

The light is red.

For details about the ERR Indicator display, see *"3.4.4 EtherCAT Indicators"* .

*5 AL Status sets an error code at 0134h to 0135h "AL Status Code" of the ESC register when there is a problem in EtherCAT communication.

*6 Err16.0.0 "Overload protection" When issued, it can be cleared 10 seconds after issuance.

If the device is not in a clearable state when the alarm clear command is sent, only the alarm clear command is accepted, and then the clearing process is performed when the device is in a clearable state.

*7 If Err40.0.0 "Absolute system down error protection" or Err42.0.0 "Absolute overspeed error protection" occurs, the error cannot be cleared until an absolute clear is executed.

*8 Alarm clear is switched between enabled and disabled by Pr6.86:bits 2 to 0 "Retracting operation alarm clear attribute".

bit 0:Err87.1.0 "Retracting operation completion (I/O)" alarm clear attribute

bit 1:Err87.2.0 "Retracting operation completion (communication)" alarm clear attribute

bit 2:Err87.3.☐ "Retracting operation error" alarm clear attribute

In all cases, 0: Alarm clear disable, 1: Alarm clear enable.

*9 The attribute for Err87.1.0 "Retracting operation completion (I/O)" and Err87.2.0 "Retracting operation completion (communication)" is the emergency stop response alarm, but when the conditions to initiate the retracting operation are met, operation proceeds according to the retracting operation function, not according to Pr5.10 "Sequence at alarm" and an alarm is generated after the retracting operation is complete.

For details on retracting operation function, see *"8.10 Retracting Operation Function"* .

The alarm behaves as an emergency stop response alarm, with the fall prevention function triggered when an alarm is generated after completion of the retracting operation.

For the fall prevention function when an alarm is triggered, see *"8.17 Fall Prevention Function for When Alarm is Triggered"* .

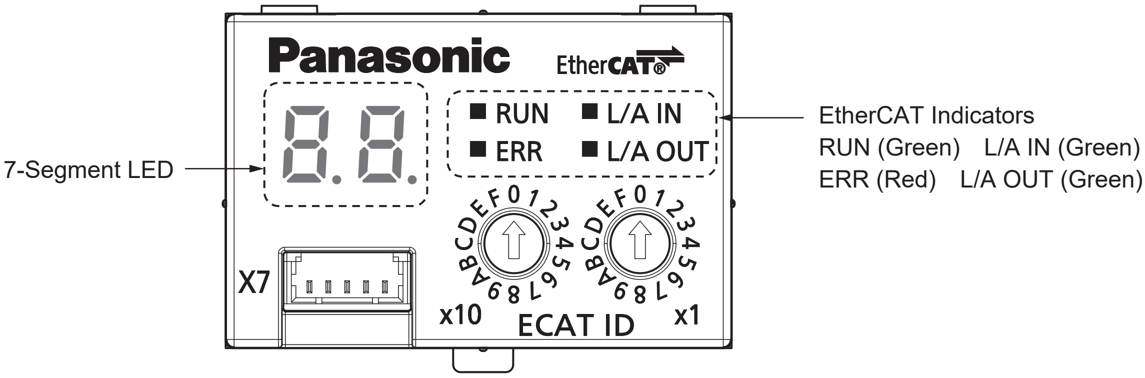
### 10.2.3 Protection Function Details

This shows details of protection functions.

The AL Status Code and ESM state are updated to the latest EtherCAT related error status every time an EtherCAT related error is detected.

However, the display at Set-up Support Software (PANATERM ver.7) , the 7-segment LED display, and the Abort message are not updated to the latest EtherCAT-related error status, and the first alarm number detected is displayed. The display of the first detected alarm number is retained until the alarm is cleared.

Check the front panel configuration in the figure below for the locations of the various LEDs and EtherCAT indicators.



**Err11.0.0 “Control power supply undervoltage protection”**

| | |
|---|---|
| Primary cause | The voltage across PN of the control power supply converter has fallen and dropped below the specified value.<br>Consider the following causes.<br>1 There was a momentary power failure due to low power supply voltage or a drop in power supply voltage.<br>2 Power supply voltage dropped due to inrush current on powering up the main power supply leading to insufficient power supply capacity.<br>3 The product is malfunctioning. |
| Handling | Measure the L1C-L2C line voltage of connector and terminal block.<br>Next, take the actions listed in “1” to “3” below for the cause with the respective corresponding number.<br>1 Increase the supply voltage or replace the power supply with another one.<br>2 Increase the power supply capacity.<br>3 Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

## Err12.0.0 “Overvoltage protection”

| | |
|---|---|
| Primary cause | ● Power supply voltage exceeds the allowable input voltage across PN of the converter.<br>● Power supply voltage is high.<br>● A voltage surge has occurred due to the phase advance capacitor or UPS (Uninterruptible Power Supply).<br>Consider the following causes.<br>1 The regenerative resistor was disconnected.<br>2 The external regenerative resistor is unsuitable and unable to absorb the regenerative energy.<br>3 The product is malfunctioning. |
| Handling | Measure the line voltage between connectors (L1, L2, L3).<br>Input the correct voltage.<br>Remove the phase advance capacitor.<br>Next, take the actions listed in “1” to “3” below for the cause with the respective corresponding number.<br>1 Use a tester to measure the resistance of the external resistor between the P and B terminals of this product and replace the external resistor if the tester reads ∞, as this means a broken connection.<br>2 Change to the specified regenerative resistance value and wattage.<br>3 Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

## Err13.0.☐ “Main power supply undervoltage protection (voltage across PN)” , Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)”

- Err13.0.0 to Err13.0.1 “Main power supply undervoltage protection (voltage across PN)”
- Err13.1.0 “Main power supply undervoltage protection (AC interrupt detection)”

| | |
|---|---|
| Primary cause | ● When Pr5.08 “L/V trip selection upon main power off” :bit 0 = 1, power is instantaneously interrupted between L1 and L3 for at least the time set with Pr5.09 “Detection time of main power off” .<br>● The voltage across PN of the main power supply converter has fallen and dropped below the specified value during servo-on.<br>Consider the following causes.<br>1 There was a momentary power failure due to low power supply voltage or a drop in power supply voltage.<br>2 Momentary power failure has occurred even though power supply voltage is normal.<br>3 Power supply capacity was insufficient.<br>Power supply voltage dropped due to inrush current on powering up the main power supply.<br>4 The product is malfunctioning. |
| Handling | Measure the line voltage between connectors (L1, L2, L3).<br>Next, take the actions listed in “1” to “4” below for the cause with the respective corresponding number.<br>1 Increase the power supply voltage, change the power supply, eliminate whatever caused the electromagnetic contactor in the main power supply to drop, then turn the power back on.<br>2 Check the setting for Pr5.09 “Detection time of main power off” and set it properly for each phase of the power supply.<br>3 Increase the power supply capacity.<br>For information on power supply capacity, see *“1.8.2.2 List of Peripheral Devices”* .<br>4 Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err13.2.0 “Main power supply phase loss protection (AC interception detection)”

| | |
|---|---|
| Primary cause | Missing phases of connectors (L1, L2, L3) were detected with main power supply established when Pr6.104 “Open-phase monitoring setup” = 2 (alarm enabled) or when using a 3-phase input dedicated servo driver and Pr6.104 = 0 (automatic) is set.<br>The cause may be that phases L1, L2, and L3 are disconnected or dropped, or that a three-phase input specification servo driver has operated with a single-phase power supply.<br>Additionally, consider the following causes.<br>1 L1-L2 line voltage, L2-L3 line voltage, and L1-L3 line voltage are not balanced.<br>2 Main power supply voltage is low.<br>3 The product is malfunctioning. |
| Handling | Check the connection of the main power input line.<br>If there is no problem with the connection, measure the line voltage between connectors (L1, L2, L3).<br>Next, take the actions listed in “1” to “3” below for the cause with the respective corresponding number.<br>1 Measure the line voltage between connectors (L1, L2, L3) and eliminate line voltage imbalance.<br>2 Confirm that the line voltage between connectors (L1, L2, L3) is the specified value.<br>3 Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

Related parameters

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 104 | B | Open-phase monitoring setup | 0 to 3 | — | Sets open-phase monitoring. A setting value of 0 (automatic) disables open-phase monitoring for servo drivers with single-phase/three-phase common specifications, and enables alarms for servo drivers with three-phase input only.<br>0: Automatic<br>1: Warning enabled<br>2: Alarm enabled<br>3: Disabled |

*1 For attributes, see *“6.2 Object Dictionary List”* .

### Err14.0.0 “Overcurrent protection 1” , Err14.1.0 “Overcurrent protection 2”

| | |
|---|---|
| Primary cause | Current through the converter has exceeded the specified value.<br>Consider the following causes.<br>1 If this alarm occurs immediately when the motor cables are disconnected and after servo-on, the product is malfunctioning.<br>(Circuit, IGBT component failure)<br>2 Short in motor cables U, V, W.<br>3 Check the insulation resistance between motor cables U, V, W and the motor earth cable and if there is an insulation failure, there is an earth fault in the motor wire.<br>4 Check the resistance balance between the various motor cables and if there is an imbalance, the motor is burned out.<br>5 Connection fault in motor cables.<br>6 Dynamic brake relay has fused due to frequent servo-on/servo-off operation.<br>7 The timing of the command input is either the same as or earlier than servo-on. |

| | |
|---|---|
| Handling | Take the actions listed in “1” to “7” below for the cause with the respective corresponding number.<br>1 Replace the servo driver with a new one.<br>2 Check for any stray strands in the lead wires at the connectors, and connect the motor cables correctly.<br>3 Replace the motor.<br>4 Replace the motor.<br>5 Remove and check the connector pins in the U, V, W, connectors on the motor and firmly secure to ensure they are not loose or disconnected.<br>6 Replace the servo driver.<br>Do not operate or stop via servo-on/off after replacement.<br>7 Wait at least 100 ms after servo-on before inputting a command. |

### Err14.1.1 “Overheat protection 2”

| | |
|---|---|
| Primary cause | Temperature of the power element of this product has risen over the specified temperature.<br>Consider the following causes.<br>1 The ambient temperature of this product has risen over the specified temperature.<br>2 Used with overload. |
| Handling | Take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>1 Improve the ambient temperature and cooling conditions of this product.<br>2 Take the following actions.<br>● Increase the capacity of the servo driver and motor.<br>● Set a longer acceleration/deceleration time.<br>● Lighten the load. |

### Err14.1.2 “Overheat protection 3”

| | |
|---|---|
| Primary cause | The dynamic brake circuit overheated and the thermal fuse has blown. |
| Handling | Replace the servo driver. |

### Err15.0.0 “Overheat protection 1”

| | |
|---|---|
| Primary cause | Temperature of the heat sink of this product has risen over the specified temperature.<br>Consider the following causes.<br>1 The ambient temperature of this product has risen over the specified temperature.<br>2 Used with overload. |
| Handling | Make sure that the ambient temperature of this product does not exceed the operating temperature range.<br>Next, take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>1 Improve the ambient temperature and cooling conditions of this product.<br>2 Take the following actions.<br>● Increase the capacity of the servo driver and motor.<br>● Set a longer acceleration/deceleration time.<br>● Lighten the load. |

## Err15.1.0 “Encoder overheat error protection”

| | |
|---|---|
| Primary cause | The encoder temperature has exceeded the encoder overheat error level.<br>Consider the following causes.<br>1 The ambient temperature of the motor is high.<br>2 Used with overload. |
| Handling | Take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>1 Improve the ambient temperature and cooling conditions of the motor.<br>2 Take the following actions.<br>● Increase the capacity of the servo driver and motor.<br>● Set a longer acceleration/deceleration time.<br>● Lighten the load. |

Related parameters

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 10 | B | Function expansion setup | -32768 to 32767 | — | bit 11: Encoder overheat error protection detection<br>0: Disabled<br>1: Enabled |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## Err16.0.0 “Overload protection”

| | |
|---|---|
| Primary cause | When the actual running value of the torque command exceeds the overload level set by Pr5.12 “Motor overload level setup” , overload protection will be triggered based on the time characteristics.<br>Consider the following causes.<br>1 Operation was continued for a long time under a heavy load and with the effective torque exceeding the rated torque.<br>2 Due to poor gain adjustment, oscillation or hunting operation, or vibration or abnormal noise from the motor occurred, or the Pr0.04 “Inertia ratio” setting is abnormal.<br>3 Motor is wired incorrectly or there is a disconnection.<br>4 The equipment to which the motor is mounted is interfering in some way.<br>Or the load was suddenly increased due to a problem with the equipment to which the motor is mounted.<br>5 Operated with the holding brake engaged.<br>6 When wiring multiple machines, there was a wiring error with the motor cable connected to the wrong axis.<br>7 Pr5.12 “Motor overload level setup” is too low. |
| Handling | ● Check that the torque (current) waveform does not oscillate or fluctuate excessively up and down in the analog output or communication.<br>● Check the overload warning display and load factor on the front panel or in the communication.<br>Next, take the actions listed in “1” to “7” below for the cause with the respective corresponding number.<br>1 Take the following actions.<br>● Increase the capacity of the servo driver and motor.<br>● Set a longer acceleration/deceleration time.<br>● Lighten the load.<br>2 Readjust the gain.<br>3 Connect the motor wiring according to the wiring diagram, and if this does not improve the problem, replace the cables.<br>4 Eliminate problems with the machinery and lighten the load.<br>5 Measure the brake terminal voltage and release the brake.<br>6 Wire the motor cables and encoder cables correctly to match the axes.<br>7 Set Pr5.12 “Motor overload level setup” = 0.<br>(Set to the maximum value allowed for the motor)<br>**Notes**<br>● For details on how to confirm the overload protection time characteristics, see *“10.2.5 Overload Protection Time Characteristics Confirmation Method”* . |

## Err16.1.0 “Torque saturation error protection”

| | |
|---|---|
| Primary cause | The torque saturation condition continued between Pr7.16 “Torque saturation error protection frequency” or Pr6.57 “Torque saturation error protection detection time” setting values. |
| Handling | Check the operating state of this product and take the same action as for Err16.0.0. |

### Err18.0.0 “Regenerative overload protection”

| | |
|---|---|
| Primary cause | The regenerative energy has exceeded the processing capacity of the regenerative resistor.<br>Consider the following causes.<br>1 The converter voltage was increased by the regenerative energy during deceleration due the size of the load inertia, which further increased the voltage due to insufficient absorption of energy by the regenerative resistor.<br>2 Regenerative energy was not absorbed in the specified deceleration time due to high number of rotations of the motor.<br>3 The operating limit of the external resistor is limited to 10% duty. |
| Handling | Check the regenerative resistance load factor on the front panel or in the communication.<br>Cannot be used with continuous regeneration control.<br>Next, take the actions listed in “1” to “3” below for the cause with the respective corresponding number.<br>1 When checking the operating pattern (velocity monitor), check the regenerative resistance load factor and the over-regeneration warning display and take the following actions.<br>● Increase the capacity of the motor and servo driver.<br>● Increase the acceleration/deceleration time.<br>● Install an external regenerative resistor.<br>2 When checking the operating pattern (velocity monitor), check the regenerative resistance load factor and the over-regeneration warning display and take the following actions.<br>● Increase the capacity of the motor and servo driver.<br>● Increase the acceleration/deceleration time.<br>● Reduce the number of rotations of the motor.<br>● Install an external regenerative resistor.<br>3 Set Pr0.16 “External regenerative resistor setup” to 2.<br>Be sure to install external protection such as a thermal fuse when Pr0.16 “External regenerative resistor setup” is set to 2.<br>**— Precautions —**<br>● If external protection is not installed, regenerative resistor protection may be lost, so that the regenerative resistor heats up abnormally and burns out. |

### Err18.1.0 “Regenerative transistor error protection”

| | |
|---|---|
| Primary cause | The regenerative drive transistor of this product is malfunctioning. |
| Handling | Replace the servo driver. |

### Err21.0.☐ “Encoder communication disconnection error protection”

- Err21.0.0 to Err21.0.1 “Encoder communication disconnection error protection”
- Err21.0.90 “Encoder communication disconnection error protection”

| | |
|---|---|
| Primary cause | Communication between the encoder and this product has been interrupted a set number of times, triggering the disconnection detecting function. |
| Handling | ● Wire the encoder cables correctly.<br>● Connect the connector pin correctly. |

## Err21.1.□ “Encoder communication error protection”

- Err21.1.0 to Err21.1.3 “Encoder communication disconnection error protection”

| | |
|---|---|
| Primary cause | This is primarily a data error due to noise.<br>● There is a communication error in data from the encoder.<br>● The encoder cables are connected but there is an error in the communication data. |
| Handling | ● Keep the encoder power supply voltage at 5 V DC ±5% (4.75 to 5.25 V).<br>This is particularly important when the encoder cables are long.<br>● If the motor cables and encoder cables are bundled together, separate them.<br>● Connect shielding to FG. |

## Err23.0.0 “Encoder communication data error protection”

| | |
|---|---|
| Primary cause | This is primarily a data error due to noise.<br>● Communication data from the encoder has become abnormal, even though there is not a communication error.<br>● The encoder cables are connected but there is an error in the communication data. |
| Handling | ● Keep the encoder power supply voltage at 5 V DC ±5% (4.75 to 5.25 V).<br>This is particularly important when the encoder cables are long.<br>● If the motor cables and encoder cables are bundled together, separate them.<br>● Connect shielding to FG. |

## Err24.0.0 “Position deviation excess protection”

| | |
|---|---|
| Primary cause | The position deviation pulse has exceeded the setting for Pr0.14 “Position deviation excess setup” .<br>Consider the following causes.<br>1 Motor movement is not tracking commands.<br>2 The value of Pr0.14 “Position deviation excess setup” is low. |
| Handling | Take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>1 Take the following actions.<br>● Check that the motor is rotating according to position command pulses.<br>● Check whether the torque output by the torque monitor is saturated.<br>● Adjust the gain.<br>● Maximize Pr0.13 “1st torque limit” and Pr5.22 “2nd torque limit” .<br>● Wire the encoder connections according to the wiring diagram.<br>● Increase the acceleration/deceleration time.<br>● Lighten the load and decrease the velocity.<br>2 Increase the value set for Pr0.14. |

Related parameters

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 0 | 14 | A | Position deviation excess setup | 0 to $2^{30}$ | Command unit | Sets the position deviation excess setup range. Err24.0.0 “Position deviation excess protection” detection is disabled when the setup value is 0.<br>Units follow Pr5.20 “Position setup unit select” .<br>The factory default value is equivalent to 10 motor revolutions at 23 bits. If the command pulse per single-turn is changed, this setup value will also be affected. Configure settings appropriately according to the safety features of the equipment. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## Err24.1.0 “Speed deviation excess protection”

| | |
|---|---|
| Primary cause | The difference between the internal position command speed and the actual speed (speed deviation) has exceeded the value set for Pr6.02 “Speed deviation excess setup” .<br>**— Precautions —**<br>● If the internal position command speed is forcibly set to 0 by an emergency stop caused by an over-travel inhibit input in a positive direction or negative direction, the speed deviation increases in that instant.<br>Make sure there is enough allowance in the setting because the internal position command speed rise time and the speed deviation will also be large in this case. |
| Handling | ● Increase the value set for Pr6.02 “Speed deviation excess setup” .<br>● Lengthen the acceleration/deceleration time for the internal position command speed, or improve tracking by adjusting the gain.<br>● Disable excessive speed deviation detection (Pr6.02 = 0). |

Related parameters

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 02 | A | Speed deviation excess setup | 0 to 20000 | r/min | Sets the threshold for Err24.1.0 “Speed deviation excess protection” .<br>Detection of speed deviation excess protection is disabled when this setup value is 0. |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## Err25.0.0 “Hybrid deviation excess protection”

| | |
|---|---|
| Primary cause | When in full-closed control, the load position from the external scale and the motor position from the encoder have shifted more than the number of pulses set by Pr3.28 “Hybrid deviation excess setup” . |
| Handling | ● Check the motor and load connections.<br>● Check connection of the external scale and this product.<br>● If the load has moved, check that the change in motor position (encoder feedback value) and the change in load position (external scale feedback value) have the same sign.<br>● Check if Pr3.24 “Numerator of external scale division” , Pr3.25 “Denominator of external scale division” , and Pr3.26 “Reversal of direction of external scale” are set correctly. |

## Err26.0.0 “Overspeed protection”

| | |
|---|---|
| Primary cause | The motor rotational speed has exceeded the value set for Pr5.13 “Over-speed level setup” . |
| Handling | ● Do not give excessively high speed commands.<br>● Check the input frequency of command pulses and the dividing/multiplying ratio.<br>● Adjust the gain if overshoot is generated due to poor gain adjustment.<br>● Wire the encoder cables according to the wiring diagram. |

### Err26.1.0 “2nd Overspeed protection”

| | |
|---|---|
| Primary cause | The motor rotational speed has exceeded the value set for Pr6.15 “2nd overspeed level setting” . |
| Handling | ● Do not give excessively high speed commands.<br>● Check the input frequency of command pulses and the dividing/multiplying ratio.<br>● Adjust the gain if overshoot is generated due to poor gain adjustment.<br>● Wire the encoder cables according to the wiring diagram. |

### Err27.1.0 “Absolute clear protection”

| | |
|---|---|
| Primary cause | Absolute encoder multi-turn data clear was executed with Set-up Support Software (PANATERM ver.7) . |
| Handling | Confirm that absolute encoder multi-turn data clear was executed with Set-up Support Software (PANATERM ver.7) .<br>**Notes**<br>● Err27.1.0 “Absolute clear protection” is a safety measure and not an error. |

### Err27.4.0 “Position command error protection”

| | |
|---|---|
| Primary cause | The position command variation (value after electronic gear) exceeded the specified value.<br>Or, when the backlash compensation function is enabled (Pr7.04 “Backlash compensation enable” :bits 1 to 0 are non-zero), the value set in Pr7.05 “Backlash compensation value” is not appropriate. |
| Handling | ● Confirm that there is no great position command variation as a result of cyclic position control (csp)<br>● Check the electronic gear ratio<br>Or, check Pr7.05 “Backlash compensation value” .<br>● Because homing is not completed after Err27.4.0 has occurred in incremental mode, rerun homing after clearing the alarm. |

### Err27.5.0 “Command generation error protection”

| | |
|---|---|
| Primary cause | An error, such as position command generation processing exceeding the computation range, has occurred. |
| Handling | Confirm that the electronic gear ratio and acceleration/deceleration constraints are fulfilled. |

### Err27.6.0 “Operation command contention protection”

| | |
|---|---|
| Primary cause | When Pr7.99 “Communication function extended setup 6” :bit 0 = 1, a servo-on command was received by EtherCAT communication while the frequency characteristics analysis function (FFT function) that operates with this product alone, as well as a trial run, were being executed. |
| Handling | When Pr7.99 “Communication function extended setup 6” :bit 0 = 1, check whether the host device has sent a servo-on command by EtherCAT communication during frequency characteristics analysis function (FFT function) or trial run execution. |

### Err27.6.1 “Operation command contention protection”

| | |
|---|---|
| Primary cause | When Pr7.99 “Communication function extended setup 6” :bit 0 = 0, EtherCAT communication was established while the frequency characteristics analysis function (FFT function) that operates with this product alone, as well as a trial run, were being executed. |
| Handling | When Pr7.99 “Communication function extended setup 6” :bit 0 = 0, check whether EtherCAT communication has been established during frequency characteristics analysis function (FFT function) or trial run execution. |

### Err27.7.0 “Position information initialization error protection”

| | |
|---|---|
| Primary cause | In homing position control mode (hm), homing was canceled by Obj.6040h:00h “Controlword” :bit 8 “halt” or similar function from the host device during the period from home detection to when homing is completed. |
| Handling | Check if homing is being canceled in proximity to the home signal. |

### Err28.0.0 “Pulse regeneration limit protection”

| | |
|---|---|
| Primary cause | The output frequency of pulse regeneration has exceeded the limit. |
| Handling | ● Check the setup values of Pr0.11 “Number of output pulses per motor revolution” and Pr5.03 “Denominator of pulse output division” .<br>● Set Pr5.33 “Pulse regenerative output limit setup” to 0.<br>**— Precautions —**<br>● This disables detection of the pulse regeneration limit.<br>Note that this action does not resolve the primary cause. |

### Err29.1.0 “Counter overflow protection 1”

| | |
|---|---|
| Primary cause | ● The calculated value of absolute encoder (absolute external scale) position [pulse unit]/ electronic gear ratio exceeded 32-bit width when the position information initialization process was performed under the following conditions.<br>• After turning on control power in absolute mode<br>• When communication is established (when ESM state transitions from Init → PreOP)<br>• When clearing of multi-turn data via Set-up Support Software (PANATERM ver.7) and EtherCAT<br>• When the Set-up Support Software (PANATERM ver.7) function (trial run, frequency characteristics analysis, Z-phase search, One Minute TUNING) ends<br>• When Config is executed by Set-up Support Software (PANATERM ver.7)<br>● An overflow has occurred in the calculation process. |
| Handling | Check the operational range for the absolute encoder (absolute external scale) position and review the electronic gear ratio. |

### Err29.2.☐ “Counter overflow protection 2”

- Err29.2.0 to Err29.2.5 “Counter overflow protection 2”

| | |
|---|---|
| Primary cause | ● When using semi-closed control<br>The value of position deviation in pulse units has exceeded ± ($2^{34}$–1) (17179869183).<br>The value of position deviation in command units has exceeded ± $2^{30}$ (1073741824).<br>● When using full-closed control<br>The value of position deviation in pulse units has exceeded ± $2^{30}$ (1073741824).<br>The value of position deviation in command units has exceeded ± $2^{30}$ (1073741824). |
| Handling | ● Check whether the motor is rotating according to the position command.<br>● Check whether the torque output by the torque monitor is saturated.<br>● Tune the gain.<br>● Maximize the torque limit setting.<br>● Wire the encoder connections according to the wiring figure. |

### Err31.0.☐ “Safety function error protection 1”

- Err31.0.0 to Err31.0.2 “Safety function error protection 1”
- Err31.0.10 to Err31.0.12 “Safety function error protection 1”
- Err31.0.20 to Err31.0.25 “Safety function error protection 1”
- Err31.0.30 to Err31.0.37 “Safety function error protection 1”
- Err31.0.40 to Err31.0.43 “Safety function error protection 1”

| | |
|---|---|
| Primary cause | A safety function has detected an error. |
| Handling | ● If this repeats even after taking action to resolve the error, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair).<br>● When any of Err31.0.10 to Err31.0.12 occurs, please check that a state of differing logic between SF1 and SF2 has not persisted for more than 10 seconds. |

### Err31.2.☐ “Safety function error protection 2”

- Err31.2.0 to Err31.2.3 “Safety function error protection 2”

| | |
|---|---|
| Primary cause | A safety function has detected an error. |
| Handling | If this repeats even after taking action to resolve the error, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err33.0.0 “Input overlapping assignment error 1 protection”

| | |
|---|---|
| Primary cause | There are overlapping input signal (SI1, SI2, SI3, and SI4) function assignment settings. |
| Handling | Assign the functions correctly to the connector pins. |

### Err33.1.0 “Input overlapping assignment error 2 protection”

| | |
|---|---|
| Primary cause | There are overlapping input signal (SI5, SI6, SI7, and SI8) function assignment settings. |
| Handling | Assign the functions correctly to the connector pins. |

### Err33.2.0 “Input function number error 1 protection”

| | |
|---|---|
| Primary cause | ● There are undefined numbers specified in input signal (SI1, SI2, SI3, and SI4) function assignments.<br>Or there is an error in logical settings.<br>● When using Dynamic brake switching input (DB-OFF), forced alarm input (E_STOP) at input signals SI1, SI2, SI3, and SI4, only one or two control modes were set. |
| Handling | Assign the functions correctly to the connector pins. |

### Err33.3.0 “Input function number error 2 protection”

| | |
|---|---|
| Primary cause | ● Undefined numbers have been specified in the input signal (SI5, SI6, SI7, SI8) function assignment settings.<br>Or there is an error in logical settings.<br>● When using Dynamic brake switching input (DB-OFF), forced alarm input (E_STOP) at input signals SI5, SI6, SI7, and SI8, only one or two control modes were set. |
| Handling | Assign the functions correctly to the connector pins. |

### Err33.4.0 “Output function number error 1 protection”

| | |
|---|---|
| Primary cause | An undefined number has been specified in the output signal (SO1) function assignment setting. |
| Handling | Assign the functions correctly to the connector pins. |

### Err33.5.0 “Output function number error 2 protection”

| | |
|---|---|
| Primary cause | There are undefined numbers specified in output signals (SO2 and SO3) function assignments. |
| Handling | Assign the functions correctly to the connector pins. |

### Err33.8.0 “Latch input assignment error protection”

| | |
|---|---|
| Primary cause | There are errors in latch correction pin (SI5, SI6, and SI7) function assignments.<br>● EXT1 and EXT2 are assigned to pins other than SI5 to SI7.<br>● Not all the control modes have been assigned. |
| Handling | Assign the functions correctly to the connector pins. |

### Err34.0.0 “Motor movable range setup error protection”

| | |
|---|---|
| Primary cause | When a position command within the specified range is input, the motor has operated outside its movable range specified in Pr5.14 “Motor working range setup” .<br>Consider the following causes.<br>1 The gain is not suitable.<br>2 The value set for Pr5.14 is low.<br>3 When Pr6.97 “Function expansion setup 3” :bit 2 = 1, the conditions for forcibly issuing Err34.0.0 were fulfilled. |
| Handling | Next, take the actions listed in “1” to “3” below for the cause with the respective corresponding number.<br>1 Check the gain (balance between position loop gain and speed loop gain) and inertia ratio.<br>2 Increase the value set for Pr5.14, or set Pr5.14 to 0 and disable the protection function.<br>3 Review the setting and operating conditions.<br>See *“7.2.4 Motor Working Range Setup Function”* . |

### Err34.1.0 “Single-turn absolute movable range error protection”

| | |
|---|---|
| Primary cause | When an absolute encoder is connected, and Pr0.15 “Absolute encoder setup” = 3, the motor (encoder) position went outside the motor movable range (encoder single-turn data). |
| Handling | ● Check the operational range for the absolute encoder (absolute scale) position including Obj.607Ch:00h “Home offset” and review the electronic gear ratio.<br>● Return the motor (encoder) position to within the motor movable range (in the encoder single-turn data).<br>● Return the command position to within the motor movable range (in the encoder single-turn data). |

## Err36.☐.0 “EEPROM parameter error protection”

- Err36.0.0 to Err36.1.0 “EEPROM parameter error protection”

| | |
|---|---|
| Primary cause | Data in the parameter storage area has been damaged when reading the data from EEPROM at power-on. |
| Handling | ● Reset all parameters.<br>● If this happens repeatedly, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

## Err37.☐.0 “EEPROM check code error protection”

- Err37.0.0 to Err37.2.0 “EEPROM check code error protection”

| | |
|---|---|
| Primary cause | Data for EEPROM write confirmation was damaged when the data was read from the EEPROM at power-on. |
| Handling | ● The product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair). |

## Err38.0.0 “Over-travel inhibit input protection 1”

| | |
|---|---|
| Primary cause | ● Positive direction/negative direction over-travel inhibit input (POT, NOT) were both switched ON when Pr5.04 “Over-travel inhibit input setup” = 0.<br>● One of positive direction/negative direction over-travel inhibit input (POT, NOT) was switched ON when Pr5.04 “Over-travel inhibit input setup” = 2. |
| Handling | Check that there are no anomalies with the switches, cables or power supply connected to the positive direction over-travel inhibit input/negative direction over-travel inhibit input.<br>In particular, check that the rise in the control signal power supply (12 to 24 V DC) is not delayed. |

## Err38.1.0 “Over-travel inhibit input protection 2”

| | |
|---|---|
| Primary cause | ● An operating command (trial run, frequency characteristics analysis function (FFT function), etc.) was received from Set-up Support Software (PANATERM ver.7) while Pr5.04 “Over-travel inhibit input setup” = 0, 1 and EtherCAT communication is in an off state and either POT or NOT are in an on state.<br>● POT or NOT was turned on while an operating command from Set-up Support Software (PANATERM ver.7) was in operation. |
| Handling | Check that there are no anomalies with the switches, cables or power supply connected to the positive direction/negative direction over-travel inhibit input.<br>In particular, check that the rise in the control signal power supply (12 to 24 V DC) is not delayed. |

## Err38.2.0 “Over-travel inhibit input protection 3”

| | |
|---|---|
| Primary cause | POT or NOT was set to a value other than Pr5.04 “Over-travel inhibit input setup” = 1 (CoE-side deceleration to stop) while the assignment function implemented any of SI5 to SI7. |
| Handling | Check that Pr5.04 “Over-travel inhibit input setup” = 1 (CoE-side deceleration to stop) is configured. |

### Err39.0.0 “Analog input (AIN) excess protection”

| | |
|---|---|
| Primary cause | A voltage higher than that set in Pr4.24 “Analog input (AIN) excessive setting” was applied to analog input. |
| Handling | ● Correctly configure Pr4.24 “Analog input (AIN) excessive setting” correctly.<br>● Check the connection status of the input/output connector.<br>● Set Pr4.24 to 0 and disable the protection function. |

### Err40.0.0 “Absolute system down error protection”

| | |
|---|---|
| Primary cause | 1 The power supply to the absolute encoder and the battery power supply are down and the built-in capacitor voltage dropped below the specified value.<br>2 The absolute encoder has not been cleared even once by the batteryless absolute encoder. |
| Handling | Take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>1 Connect the absolute encoder battery and then clear the absolute encoder (battery backup).<br>2 Clear the batteryless absolute encoder.<br>For absolute encoder clearing operation, see *“2.4.3 Setup (Initialization) of Absolute Encoder”* . |

### Err41.0.0 “Absolute counter over error protection”

| | |
|---|---|
| Primary cause | The multi-turn counter of the absolute encoder has exceeded the specified value. |
| Handling | ● Clear the absolute encoder near the center of the movable range such that the amount of movement from the center of the movable range is within 32765 rotations.<br>● Change Pr0.15 “Absolute encoder setup” to the setting value 2 (absolute system: ignore multi-turn counter over), and consider monitoring the multi-turn data with the host device. |

### Err42.0.0 “Absolute overspeed error protection”

| | |
|---|---|
| Primary cause | If this happens while using an absolute encoder (battery backup), consider the following causes.<br>1 The motor rotational speed has exceeded the specified value when only battery power is being supplied during a power failure.<br>2 The encoder power has been interrupted for some reason during normal operation and switched to power failure mode, and the rotational speed has exceeded the specified value.<br>**Notes**<br>● This does not happen with a batteryless absolute encoder. |
| Handling | Take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>To clear the alarm, in addition to performing the following actions, the absolute encoder must be cleared.<br>For absolute encoder clearing operation, see *“2.4.3 Setup (Initialization) of Absolute Encoder”* .<br>1 Check whether there is external drive during the power failure and check the rotational speed if there is, and operate at a speed below the specified value.<br>2 Take the following actions.<br>● Check the power supply voltage (5 V ±5%) on the encoder side.<br>● Check the connection status of the Connector X6. |

### Err44.0.0 “Single-turn counter error protection”

| | |
|---|---|
| Primary cause | A single-turn counter error has been detected. |
| Handling | Replace the motor with a new one.<br>Return the motor that generated the alarm to the vendor for examination (repair). |

### Err45.0.0 “Multi-turn counter error protection”

| | |
|---|---|
| Primary cause | A multi-turn counter error has been detected. |

| | |
|---|---|
| Handling | Replace the motor with a new one.<br>Return the motor that generated the alarm to the vendor for examination (repair). |

### Err47.0.0 “Absolute status error protection”

| | |
|---|---|
| Primary cause | The encoder turned more than the specified value during power-up. |
| Handling | Set so that the motor does not operate during power-up. |

### Err50.0.0 “External scale wiring error protection”

| | |
|---|---|
| Primary cause | Communication between the external scale and this product has been interrupted more than a set number of times, triggering the disconnection detecting function. |
| Handling | ● Wire the external scale wiring according to the connections.<br>● Reconnect connector pins connected incorrectly. |

### Err50.1.☐ “External scale communication error protection”

- Err50.1.0 to Err50.1.2 “External scale communication error protection”

| | |
|---|---|
| Primary cause | This is primarily a data error due to noise.<br>● There is a communication error in data from the external scale.<br>● The external scale connection cable is connected but there is an error in the communication data. |
| Handling | ● Keep the external scale power supply voltage at 5 V DC ±5% (4.75 to 5.25 V).<br>This is particularly important when the external scale connection cable is long.<br>● If the motor cables and external scale connection cable are bundled together, separate them.<br>● Connect shielding to FG.<br>For details on wiring, see *“3.2.6 Wiring to Connector X5 (Connecting to External Scale)”* . |

### Err50.2.0 “External scale communication data error protection”

| | |
|---|---|
| Primary cause | This is primarily a data error due to noise.<br>● There was an error in communication data from the external scale even though there was not a communication error.<br>● The external scale connection cable is connected but there is an error in the communication data. |
| Handling | ● Keep the external scale power supply voltage at 5 V DC ±5% (4.75 to 5.25 V).<br>This is particularly important when the external scale connection cable is long.<br>● If the motor cables and external scale connection cable are bundled together, separate them.<br>● Connect shielding to FG.<br>For details on wiring, see *“3.2.6 Wiring to Connector X5 (Connecting to External Scale)”* . |

### Err51.0.0 “External scale status error protection 0”

| | |
|---|---|
| Primary cause | 1 was returned for bit 0 of the external scale error code (ALMC). |
| Handling | Check the external scale specifications, resolve the cause of the error, and then clear the external scale error.<br>When that is done, shut off and reset the control power supply. |

### Err51.1.0 “External scale status error protection 1”

| | |
|---|---|
| Primary cause | 1 was returned for bit 1 of the external scale error code (ALMC). |
| Handling | Check the external scale specifications, resolve the cause of the error, and then clear the external scale error.<br>When that is done, shut off and reset the control power supply. |

### Err51.2.0 “External scale status error protection 2”

| | |
|---|---|
| Primary cause | 1 was returned for bit 2 of the external scale error code (ALMC). |
| Handling | Check the external scale specifications, resolve the cause of the error, and then clear the external scale error.<br>When that is done, shut off and reset the control power supply. |

### Err51.3.0 “External scale status error protection 3”

| | |
|---|---|
| Primary cause | 1 was returned for bit 3 of the external scale error code (ALMC). |
| Handling | Check the external scale specifications, resolve the cause of the error, and then clear the external scale error.<br>When that is done, shut off and reset the control power supply. |

### Err51.4.0 “External scale status error protection 4”

| | |
|---|---|
| Primary cause | 1 was returned for bit 4 of the external scale error code (ALMC). |
| Handling | Check the external scale specifications, resolve the cause of the error, and then clear the external scale error.<br>When that is done, shut off and reset the control power supply. |

### Err51.5.0 “External scale status error protection 5”

| | |
|---|---|
| Primary cause | 1 was returned for bit 5 of the external scale error code (ALMC). |
| Handling | Check the external scale specifications, resolve the cause of the error, and then clear the external scale error.<br>When that is done, shut off and reset the control power supply. |

### Err55.0.0 “A-phase connection error protection”

| | |
|---|---|
| Primary cause | An error, such as a broken wire, has occurred in the A-phase wiring of the external scale. |
| Handling | Check the A-phase wiring of the external scale. |

### Err55.1.0 “B-phase connection error protection”

| | |
|---|---|
| Primary cause | An error, such as a broken wire, has occurred in the B-phase wiring of the external scale. |
| Handling | Check the B-phase wiring of the external scale. |

### Err55.2.0 “Z-phase connection error protection”

| | |
|---|---|
| Primary cause | An error, such as a broken wire, has occurred in the Z-phase wiring of the external scale. |
| Handling | Check the Z-phase wiring of the external scale. |

### Err68.□.□ “Internal communication processing error protection□”

- Err68.0.0 “Internal communication processing error protection1”
- Err68.3.0 to Err68.3.3 “Internal communication processing error protection4”
- Err68.5.0 “Internal communication processing error protection6”
- Err68.6.0 “Internal communication processing error protection7”
- Err68.7.0 “Internal communication processing error protection8”
- Err68.8.0 “Internal communication processing error protection9”
- Err68.9.0 “Internal communication processing error protection10”
- Err68.10.0 “Internal communication processing error protection11”
- Err68.11.0 “Internal communication processing error protection12”
- Err68.14.0 “Internal communication processing error protection15”
- Err68.19.0 “Internal communication processing error protection20”
- Err68.21.0 “Internal communication processing error protection22”

| | |
|---|---|
| Primary cause | An error has occurred in the internal microcomputer-to-microcomputer communication. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err70.0.0 “U-phase current detector error protection 1”

| | |
|---|---|
| Primary cause | ● There is an error in the U-phase current detection offset value. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair). |

### Err70.0.1 “U-phase current detector error protection 2”

| | |
|---|---|
| Primary cause | Detected U-phase current sticking. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair). |

### Err70.1.0 “W-phase current detector error protection 1”

| | |
|---|---|
| Primary cause | ● There is an error in the W-phase current detection offset value. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair). |

### Err70.1.1 “W-phase current detector error protection 2”

| | |
|---|---|
| Primary cause | Detected W-phase current sticking. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair). |

### Err72.0.0 “Thermal error protection”

| | |
|---|---|
| Primary cause | A thermal error has occurred. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err75.0.☐ “External memory access error protection”

- Err75.0.0 to Err75.0.1 “External memory access error protection”

| | |
|---|---|
| Primary cause | An error occurred in the access process with peripheral components. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err77.0.0 “Microcomputer error protection 1”

| | |
|---|---|
| Primary cause | An error has occurred in the internal microcontroller. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err77.2.0 “Microcomputer error protection 3”

| | |
|---|---|
| Primary cause | An error has occurred in the internal microcontroller. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err77.6.☐ “Microcomputer error protection7”

- Err77.6.0 to Err77.6.3 “Microcomputer error protection7”

| | |
|---|---|
| Primary cause | ● An error has occurred in the internal microcontroller.<br>● ESC malfunctioned due to unsupported ESC register access while ESM status was beyond PreOP. |
| Handling | ● Turn the power supply off and then on again.<br>● ESC register access is restricted for this product. Check that the following registers are not being accessed:<br>0510h "MII Management Control/Status"<br>0512h "PHY Address"<br>0513h "PHY Register Address"<br>0514h "PHY Data"<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

## Err80.0.0 “ESM unauthorized request error protection”

| | |
|---|---|
| Primary cause | A state change request that is not possible from the current state has been received.<br>Init -> SafeOP<br>Init -> OP<br>PreOP -> OP |
| Detected ESM state | All ESM |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | ● When the current state is anything other than OP: Remains in the current ESM state.<br>● When the current state is OP: SafeOP |
| ESC Register AL Status Code | 0011h |
| Handling | Check the host device status change request. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

## Err80.1.0 “ESM undefined request error protection”

| | |
|---|---|
| Primary cause | Received an undefined status change request other than the following.<br>1: Request Init State<br>2: Request Pre-Operational State<br>4: Request Safe-Operational State<br>8: Request Operational State |
| Detected ESM state | All ESM |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | ● When the current state is anything other than OP: Remains in the current ESM state.<br>● When the current state is OP: SafeOP |
| ESC Register AL Status Code | 0012h |
| Handling | Check the host device status change request. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

## Err80.2.0 “Bootstrap requests error protection”

| | |
|---|---|
| Primary cause | The following change state request was received.<br>3: Request Bootstrap State |
| Detected ESM state | form Init to Bootstrap |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC Register AL Status Code | 0013h |
| Handling | Check the change state request of host controller. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### Err80.3.0 “Incomplete PLL error protection”

| | |
|---|---|
| Primary cause | ● Phase alignment (PLL lock) of EtherCAT communication synchronization could not be completed even after 1s has elapsed from the start of synchronization processing during PreOP→SafeOP transition.<br>● Obj.37B0h:00h “Communication function extended setup 7” :bit 8 (Pr7.110:bit 8) is 1, SYNC0 or interrupt processing by IRQ or interrupt processing by IRQ occurred for more than 9.5 seconds during SafeOP→OP transition after synchronization processing is completed.<br>See *“Conditions for occurrence of Err80.3.0 to Err80.7.0”* . |
| Detected ESM state | PreOP→SafeOP, SafeOp, SafeOP→OP |
| Detected synchronous mode | DC, SM2 |
| ESM state after detection | ● When the ESM state at the time of detection is in the PreOP→SafeOP transition: PreOP<br>● When the ESM state at the time of detection is in the SafeOP or during the SafeOP→OP transition: SafeOP |
| ESC Register AL Status Code | 002Dh |
| Handling | Take the following actions depending on the synchronous mode at the time of detection.<br>If the following actions do not resolve the problem, turn the power supply off and then on again.<br>If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair).<br>For DC<br>● If the ESC register 0920h “System Time Offset” is anything other than 0, check that the ESC register 0920h “System Time Offset” is set before enabling the SYNC0 signal.<br>● Check the DC setting.<br>● Check that the propagation delay compensation and drift compensation are correct.<br>For SM2<br>● Check whether the ESC register 0920h “System Time Offset” is set to anything other than 0.<br>● Confirm that the PDO send timing from the host device is consistent.<br>● Check for problems with the EtherCAT communication cable wiring.<br>● Check whether there is excessive noise on the EtherCAT communication cable.<br>● When this has been resolved, shut off and reset the control power supply. |
| Alarm clear | ○ |
| ERR Indicator Display | Single flash |

Related objects

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 37B0h | 00h | Communication function extended setup 7 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| | | ● bit 8: Err80.3.0 detection function expansion<br>0: Disabled<br>1: Enabled | | | | | | | | |

## Err80.4.0 “PDO watchdog error protection”

| | |
|---|---|
| Primary cause | 1 0220h to 0223h “AL Event Request” :bit 10 did not turn ON within the time (detection timeout value) set by ESC registers 0400h “Watchdog Divider” and 0420h “Watchdog Time Process Data” during PDO communication (in SafeOP or OP state).<br>See *“Conditions for occurrence of Err80.3.0 to Err80.7.0”* .<br>2 <If the error cannot be resolved by addressing the primary causes above, or if ESM cannot be changed to OP><br>Logical Start Address of FMMU set from EtherCAT MainDevice (controller) does not match this product's specifications. |
| Detected ESM state | SafeOP (*1) , OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | SafeOP |
| ESC Register AL Status Code | 001Bh |
| Handling | Take the actions listed in “1” to “2” below for the cause with the respective corresponding number.<br>1 Check the following and take the following actions.<br>● Confirm that the PDO send timing from the host device is consistent (is not interrupted).<br>● Increase the PDO watchdog detection timeout value.<br>● Check for problems with the EtherCAT communication cable wiring.<br>● Check whether there is excessive noise on the EtherCAT communication cable.<br>2 Take one of the following actions.<br>This product places restrictions on the Logical Start Address settings of the FMMU. See Technical Reference Communication Specification “1.2.7 Functional Differences from Previous Series” “EtherCAT SubDevice Controller” or “LRW Command for Process Data RAM Area (1000h to FFFFh)” for more information on these restrictions.<br>● In the EtherCAT MainDevice (controller) communication settings, check the Logical Start Address of the FMMU for PDO communication input and output. If the Logical Start Addresses of the two are different, change them to the same value.<br>● In the EtherCAT MainDevice (controller) communication settings, check the LRW command for PDO communication. If using the LRW command, replace it with the LRD/LWR command.<br>**— Precautions —**<br>• When replacing the LRW command with the LRD/LWR command, please do so after confirming the communication cycle, PDO size, and number of connected axes. Up to twice as much data may be required, and the number of connected axes may be halved compared to the number of connected axes currently in use, as with the MINAS A6B series.<br>If you have any questions, please contact the retailer (dealer) from which you purchased the product. |
| Alarm clear | ○ |
| ERR Indicator Display | Double flash |

*1 The watchdog at SM3 (TxPDO) is disabled with this product, and detection is only executed by the watchdog at SM2 (RxPDO). Thus, an alarm is detected only in the OP state.

## Err80.6.0 “PLL error protection”

| | |
|---|---|
| Primary cause | With the ESM state in SafeOP or OP, the phase matching (PLL lock) of EtherCAT communication synchronization has been lost.<br>See *“Conditions for occurrence of Err80.3.0 to Err80.7.0”* . |
| Detected ESM state | SafeOP, OP |
| Detected synchronous mode | DC, SM2 |
| ESM state after detection | SafeOP |

| | |
|---|---|
| ESC Register AL Status Code | 0032h |
| Handling | Take the following actions depending on the synchronous mode at the time of detection.<br>If the following actions do not resolve the problem, turn the power supply off and then on again.<br>If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair).<br>For DC<br>● If the ESC register 0920h “System Time Offset” is anything other than 0, check that the ESC register 0920h “System Time Offset” is set before enabling the SYNC0 signal.<br>● Check the DC setting.<br>● Check that the propagation delay compensation and drift compensation are correct.<br>For SM2<br>● Check whether the ESC register 0920h “System Time Offset” is set to anything other than 0.<br>● Confirm that the PDO send timing from the host device is consistent.<br>● Check for problems with the EtherCAT communication cable wiring.<br>● Check whether there is excessive noise on the EtherCAT communication cable. |
| Alarm clear | ○ |
| ERR Indicator Display | Single flash |

### Err80.7.0 “Synchronization signal error protection”

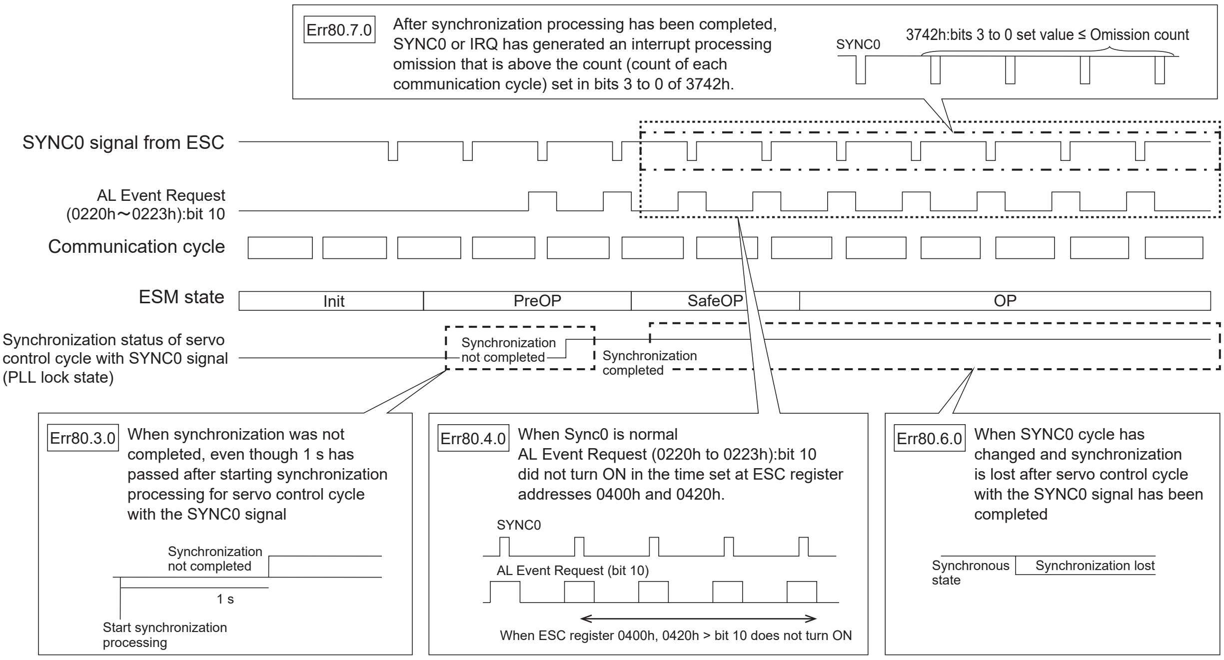
| | |
|---|---|
| Primary cause | After the completion of synchronization processing, an interrupt process missed by SYNC0 or IRQ occurred above the threshold set by Obj.3742h:00h “Maximum continuation communication error” :bits 0 to 3 (Pr7.42 “Maximum continuation communication error” :bits 3 to 0).<br>See *“Conditions for occurrence of Err80.3.0 to Err80.7.0”* . |
| Detected ESM state | If Obj.37B0h:00h “Communication function extended setup 7” :bit 7 (Pr7.110:bit 7) is 0: Safe-OP, OP<br>If Obj.37B0h:00h “Communication function extended setup 7” :bit 7 (Pr7.110:bit 7) is 1: OP |
| Detected synchronous mode | DC, SM2 |
| ESM state after detection | SafeOP |
| ESC Register AL Status Code | 002Ch |
| Handling | Take the following actions depending on the synchronous mode at the time of detection.<br>If the following actions do not resolve the problem, turn the power supply off and then on again.<br>If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the motor and servo driver with new ones.<br>Return the motor and servo driver that generated the alarm to the vendor for examination (repair).<br>For DC<br>● Check the DC setting.<br>● Check that the propagation delay compensation and drift compensation are correct.<br>For SM2<br>● Confirm that the PDO send timing from the host device is consistent.<br>● Check for problems with the EtherCAT communication cable wiring.<br>● Check whether there is excessive noise on the EtherCAT communication cable.<br>● Increase the setting value of Obj.3742h:00h “Maximum continuation communication error” :bits 3 to 0 (Pr7.42 “Maximum continuation communication error” :bits 3 to 0). |
| Alarm clear | ○ |
| ERR Indicator Display | Single flash |

Related objects

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3742h | 00h | Maximum continuation communication error | — | -32768 to 32767 | I16 | rw | No | ALL | Yes | R |
| ● Set the continuation communication error upper limit.<br>bits 3 to 0: Err80.7.0 Detection threshold (0 to 15 times, detection disabled when 0)<br>bits 7 to 4: Reserved<br>bits 11 to 8: Reserved<br>bits 15 to 12: Reserved | | | | | | | | | | |
| 37B0h | 00h | Communication function extended setup 7 | — | -2147483648 to 2147483647 | I32 | rw | No | ALL | Yes | B |
| ● bit 7: Err80.7.0 detection function expansion<br>0: Disabled<br>1: Enabled | | | | | | | | | | |

## Conditions for occurrence of Err80.3.0 to Err80.7.0

For conditions for occurrence of Err80.3.0 to Err80.7.0, an example using DC synchronization is shown in the figure below (In SM2 synchronization, the SYNC0 signal is replaced by an IRQ signal).



**Err80.7.0** After synchronization processing has been completed, SYNC0 or IRQ has generated an interrupt processing omission that is above the count (count of each communication cycle) set in bits 3 to 0 of 3742h.

**Err80.3.0** When synchronization was not completed, even though 1 s has passed after starting synchronization processing for servo control cycle with the SYNC0 signal

**Err80.4.0** When Sync0 is normal AL Event Request (0220h to 0223h):bit 10 did not turn ON in the time set at ESC register addresses 0400h and 0420h.

**Err80.6.0** When SYNC0 cycle has changed and synchronization is lost after servo control cycle with the SYNC0 signal has been completed

### Err81.0.0 “Synchronization cycle error protection”

For SYNC0 cycle setting error

| | |
|---|---|
| Primary cause | The following currently unsupported synchronization cycle (SYNC0 cycle) has been set.<br>● One of either ESC register 09A0h “SYNC0 Cycle Time” or Obj.1C32h:02h “Cycle time” has been set to a value other than 62500, 125000, 250000, 500000, 1000000, 2000000, 4000000, 8000000 or 10000000 ns. |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | DC |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 0035h |
| Handling | Correctly configure the synchronization cycle. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

For IRQ cycle setting error

| | |
|---|---|
| Primary cause | The following currently unsupported synchronization cycle (IRQ cycle) has been set.<br>● Obj.1C32h:02h “Cycle time” was set to a value other than 62500, 125000, 250000, 500000, 1000000, 2000000, 4000000, 8000000, and 10000000 ns. |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 0035h |
| Handling | Correctly configure the synchronization cycle. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

## Err81.1.0 “Mailbox error protection”

| | |
|---|---|
| Primary cause | The following Mailbox SyncManager0/1 setting is wrong.<br>● When the SyncManager0/1 Physical Start Address (ESC register: 0800h, 0801h/0808h, 0809h) setting is invalid<br>• The Mailbox receiving range and sending range are overlapping.<br>• The Mailbox sending/receiving range is overlapping the SyncManager2/3 sending/ receiving range.<br>• The address specification for the Mailbox sending/receiving range is set to an odd number.<br>● When SyncManager0/1 Length (ESC register: 0802h, 0803h/080Ah, 080Bh) setting is invalid<br>• SyncManager0: It is set outside the 32 to 256 byte range.<br>• SyncManager1: It is set outside the 40 to 256 byte range.<br>● When SyncManager0/1 Control Register (ESC register: 0804h/080Ch) setting is invalid<br>• 0804h:bits 3 to 0 are set to something other than 0110b.<br>• 080Ch:bits 3 to 0 are set to something other than 0010b. |
| Detected ESM state | Init -> PreOP, PreOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC Register AL Status Code | 0016h |
| Handling | Set Sync manager correctly as described in the ESI file. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

## Err81.4.0 “PDO watchdog setup error protection”

| | |
|---|---|
| Primary cause | The PDO watchdog setting is wrong.<br>● For DC, SM2<br>Although the PDO watchdog trigger is enabled (SyncManager: ESC register 0804h “SyncManager” :bit 6 is set to 1), the setting for the PDO watchdog detection timeout (ESC register 0400h, 0420h) is less than “Communication cycles × 2”.<br>Or, the PDO watchdog detection timeout value (ESC register 0400h) is set to 8190 or higher.<br>● For FreeRun<br>Although the PDO watchdog trigger is enabled (SyncManager: ESC register 0804h “SyncManager” :bit 6 is set to 1), the setting for the PDO watchdog detection timeout (ESC register 0400h, 0420h) is less than 2 ms.<br>Or, the PDO watchdog detection timeout value (ESC register 0400h) is set to 8190 or higher. |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 001Fh |
| Handling | Set a valid watchdog detection timeout value. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### Err81.5.0 “DC error protection”

| | |
|---|---|
| Primary cause | The DC setup is incorrect.<br>● ESC register 0981h “Activation” :bits 2 to 0 have been set to something other than the following values.<br>bits 2 to 0 = 000b<br>bits 2 to 0 = 011b |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 0030h |
| Handling | Check the DC setting. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### Err81.6.0 “SM event mode error protection”

| | |
|---|---|
| Primary cause | One of the following unsupported SM event modes has been set.<br>● Obj.1C32h:01h “Sync mode” has been set to a value other than 00h “FreeRun”, 01h “SM2”, or 02h “DC SYNC0”.<br>● Obj.1C33h:01h “Sync mode” has been set to a value other than 00h “FreeRun”, 02h “DC SYNC0”, or 22h “SM2”.<br>● ESC register 0981h “Activation” :bits 2 to 0 = 000b, and only one of either Obj.1C32h–01h or Obj.1C33h–01h has been set to SM2. |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 0028h |
| Handling | ● Set Obj.1C32h:01h “Sync mode” to any of 00h “FreeRun”, 01h “SM2” or 02h “DC SYNC0”.<br>● Set Obj.1C33h:01h “Sync mode” to any of 00h “FreeRun”, 02h “DC SYNC0” or 22h “SM2”.<br>● Match the settings for Obj.1C32h-01h and Obj.1C33h-01h. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

## Err81.7.0 “SyncManager 2 / 3 setup error protection”

### SyncManager2

| | |
|---|---|
| Primary cause | SyncManager2 setting has been set to an invalid value.<br>● When the SyncManager2 Physical Start Address (ESC register: 0810h) setting is invalid<br>• The receiving range and sending range are overlapping.<br>• The Mailbox sending/receiving range is overlapping the SyncManager2 sending/receiving range.<br>• The address specification for the sending/receiving range is set to an odd number.<br>• The start address is out of range.<br>● When the SyncManager2 Length (ESC register: 0812h) setting is invalid<br>• Differs from the RxPDO size.<br>● When the SyncManager2 Control Register (ESC register: 0814h) setting is invalid<br>• bits 3 to 2 are set to something other than 01b. |
| Detected ESM state | PreOP -> SafeOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 001Dh |
| Handling | Set SyncManager2 correctly as described in the ESI file. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### SyncManager3

| | |
|---|---|
| Primary cause | SyncManager3 setting has been set to an invalid value.<br>● When the SyncManager3 Physical Start Address (ESC register: 0818h) setting is invalid<br>• The receiving range and sending range are overlapping.<br>• The Mailbox sending/receiving range is overlapping the SyncManager3 sending/receiving range.<br>• The address specification for the sending/receiving range is set to an odd number.<br>• The start address is out of range.<br>● When the SyncManager3 Length (ESC register: 081Ah) setting is invalid<br>• Differs from the TxPDO size.<br>● When the SyncManager3 Control Register (ESC register: 081Ch) setting is invalid<br>• bits 3 to 2 are set to something other than 00b. |
| Detected ESM state | PreOP -> SafeOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 001Eh |
| Handling | Set SyncManager3 correctly as described in the ESI file. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### Err84.3.0 “Initialization of synchronization establishment error protection”

| | |
|---|---|
| Primary cause | An error occurred in the internal synchronization process. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err85.0.0 “TxPDO assignment error protection”

| | |
|---|---|
| Primary cause | The data size for the TxPDO map has been set in excess of 32 bytes. |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 0024h |
| Handling | Set the TxPDO data size to 32 bytes or less. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### Err85.1.0 “RxPDO assignment error protection”

| | |
|---|---|
| Primary cause | The data size for the RxPDO map has been set in excess of 32 bytes. |
| Detected ESM state | PreOP -> SafeOP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | PreOP |
| ESC Register AL Status Code | 0025h |
| Handling | Set the RxPDO size to 32 bytes or less. |
| Alarm clear | ○ |
| ERR Indicator Display | Blinking |

### Err85.2.0 “Lost link error protection”

| | |
|---|---|
| Primary cause | The ESM state transitions from Init -> PreOP while either Port0 or Port1 show as “Lost link” (except ports that show as “Lost link” from the moment of transition from Init -> PreOP) and the time set in Obj.3743h:00h “Lost link detection time” has elapsed. |
| Detected ESM state | PreOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC Register AL Status Code | 0000h |
| Handling | ● Check for problems with the EtherCAT communication cable wiring.<br>● Check for problems with communication from the host device. |
| Alarm clear | ○ |
| ERR Indicator Display | Double flash |

Related objects

| Index | Sub-Index | Name | Units | Range | Data Type | Access | PDO | Op-mode | EEPROM | Attribute |
|---|---|---|---|---|---|---|---|---|---|---|
| 3743h | 00h | Lost link detection time | ms | 0 to 32767 | I16 | rw | No | ALL | Yes | R |
| | ● Err85.2.0 “Lost link error protection” is triggered when the time set by this parameter has passed after the ESM state shifts from Init -> PreOP if either Port0 or Port1 show as “Lost link” (excludes Ports that show as “Lost link” from the moment of transition from Init -> PreOP).<br>● If set to 0, Err85.2.0 “Lost link error protection” detection is disabled. | | | | | | | | | |

**— Precautions —**

- This alarm is triggered only by the sub drive that detected the Lost link.
- Downline sub drives that do not detect the Lost link will not detect this alarm.
- To have the alarm detected by a downline sub device, activate the PDO watchdog to which the PDO is assigned.
- Please note that the factory default value for Obj.3743h:00h “Lost link detection time” is 0 (disabled).

### Err85.3.0 “SII EEPROM error protection”

| | |
|---|---|
| Primary cause | ● The values for VendorID, Product code and Revision number in SII (EEPROM) and the object do not match.<br>● Reading and writing of SII (EEPROM) are invalid. Or, the SII area is corrupted. The detection range is different from that of A6B.<br>● Any one of bits 14, 13, 11 at ESC register 0502h is set to 1. |
| Detected ESM state | All ESM |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Init |
| ESC Register AL Status Code | 0051h |
| Handling | ● Check the SII data.<br>● Re-execute reading and writing to and from SII. |
| Alarm clear | × |
| ERR Indicator Display | Flickering |

**— Precautions —**

- If Err85.3.0 is triggered while disconnected from the host device, it is possible that the product has failed. In such a case, replace the servo driver.

### Err87.0.0 “Forced alarm input protection”

| | |
|---|---|
| Primary cause | Forced alarm input (E-STOP) has been entered. |
| Handling | If this alarm occurs unintentionally, check the wiring as the input state of the forced alarm input (E-STOP) may be in an unintended state. |

### Err87.1.0 “Retracting operation completion (I/O)”

| | |
|---|---|
| Primary cause | The I/O retracting operation has been completed normally. |
| Handling | This is a safety measure to notify the operator that the retracting operation has been run, and is not a problem as long as the retracting operation was intended.<br>Be sure to run homing after clearing the alarm. |

### Err87.2.0 “Retracting operation completion (communication)”

| | |
|---|---|
| Primary cause | The communication retracting operation has been completed normally. |
| Handling | This is a safety measure to notify the operator that the retracting operation has been run, and is not a problem as long as the retracting operation was intended.<br>Be sure to run homing after clearing the alarm. |

## Err87.3.☐ “Retracting operation error”

| | |
|---|---|
| Primary cause | The retracting operation could not be started due to the following conditions.<br>The retracting operation may also have been interrupted.<br>● When the Pr6.85 “Retracting operation condition setting” setting has an error<br>● When the retracting operation is enabled and the communication cycle is set to less than 250 μs<br>● When over-travel inhibit input (POT, NOT) is detected during the retracting operation<br>● When the retracting operation execution condition is met in a state when over-travel inhibit input (POT, NOT) is detected<br>● When the retracting operation condition is met while an operation other than a communication command from the host (trial run, etc.) is being executed<br>● When the retracting operation is interrupted by an alarm being detected during the retracting operation<br>● When the retracting operation could not be started due to something like a servo-off state |
| Handling | ● Check that there are no problems with the parameter settings.<br>● Check that there are no problems with the operating environment.<br>● Be sure to run homing after clearing the alarm. |

## Err88.0.0 “Main power supply undervoltage protection (AC interrupt detection 2)”

| | |
|---|---|
| Primary cause | ● A main circuit power supply off was detected when the Obj.6007h:00h “Abort connection option code” setting was 1 and the PDS state was “Operation enabled” or “Quick stop active”.<br>● A Switch on command was received when the Obj.6007h:00h “Abort connection option code” setting was 1, the PDS state was “Ready to switch on” and the main circuit power supply was off. |
| Detected ESM state | PreOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Remains in the current ESM state. |
| ESC Register AL Status Code | 0000h |
| Handling | ● Increase the power supply voltage capacity, change the power supply, eliminate whatever caused the electromagnetic contactor in the main power supply to drop, then turn the power back on.<br>● Properly connect each phase (L1, L2, L3) of the power supply. Use L1, L3 for single phase 100 V and single phase 200 V.<br>● Replace the servo driver with a new one. |
| Alarm clear | ○ |
| ERR Indicator Display | OFF |

## Err88.1.0 “Control mode setting error protection”

| | |
|---|---|
| Primary cause | ● The PDS state is changed to “Operation enabled” when the set value of Obj.6060h:00h “Modes of operation” is 0 and the set value of Obj.6061h:00h “Modes of operation display” is 0.<br>● A currently unsupported control mode was set at Obj.6060h:00h “Modes of operation” .<br>● A mode other than position control was set at Obj.6060h:00h “Modes of operation” during full-closed control.<br>● One of the following was set in two-degree-of-freedom control mode (synchronization type).<br>• Obj.3001h:00h “Control mode setup” = 6 (Full-closed control)<br>• Obj.6060h:00h “Modes of operation” = 3 (pv) or 9 (csv)<br>● Was set to two-degree-of-freedom control mode (synchronization type) during velocity control or full-closed control. |
| Detected ESM state | All ESM |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Remains in the current ESM state. |
| ESC Register AL Status Code | 0000h |
| Handling | ● Check the set value of Obj.6060h:00h “Modes of operation” .<br>● Check the two-degree-of-freedom control-related parameters Pr6.47:bit 3, bit 0. |
| Alarm clear | ○ |
| ERR Indicator Display | OFF |

## Err88.2.0 “ESM requirements during operation error protection”

| | |
|---|---|
| Primary cause | ● While the PDS state was “Operation enabled” or “Quick stop active”, a command to change to another ESM state was received.<br>● When set to Obj.3799h:bit 0 = 1, a command was received from Set-up Support Software (PANATERM ver.7) to change from the current ESM state to another ESM state while the servo was on (triggering warning D2). |
| Detected ESM state | Init, PreOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Comply with the state change request from the host device. |
| ESC Register AL Status Code | 0000h |
| Handling | Check the state change request from the host device. |
| Alarm clear | ○ |
| ERR Indicator Display | OFF |

### Err88.3.0 “Improper operation error protection”

| | |
|---|---|
| Primary cause | ● EXT1/EXT2 was selected by touch probe trigger selection (Obj.60B8h:00h “Touch probe function” ) when EXT1/EXT2 was not assigned to the input signal.<br>● Z-phase was selected in the trigger selection (Obj.60B8h:00h “Touch probe function” ) of the touch probe when in full-closed absolute mode.<br>● The actual position or command position was wrapped around when the software limit function was enabled. |
| Detected ESM state | PreOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Remains in the current ESM state. |
| ESC Register AL Status Code | 0000h |
| Handling | ● Set the function assignment to the input signal correctly.<br>● Set the trigger selection correctly.<br>● Check the relationship between the operating range and software limit settings. |
| Alarm clear | × |
| ERR Indicator Display | OFF |

| | |
|---|---|
| Primary cause | ● The calculated result for the electronic gear ratio was outside the range of 128000× to 1/1000×.<br>● The denominator or numerator exceeded the unsigned 64-bit size in the process of calculating the electronic gear ratio.<br>● The denominator or numerator exceeded the unsigned 32-bit size in the final calculation result for the electronic gear ratio. |
| Detected ESM state | Init -> PreOP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Comply with the state change request from the main device. |
| ESC Register AL Status Code | 0000h |
| Handling | Review the electronic gear setting and turn the control power supply back on. |
| Alarm clear | × |
| ERR Indicator Display | OFF |

### Err91.1.0 “Command error protection”

| | |
|---|---|
| Primary cause | ● A position that cannot be reached in continuous rotating absolute encoder mode (outside the range of Obj.607Bh: “Position range limit” ) was set as the target position.<br>● A Trial Run with Set-up Support Software (PANATERM ver.7) was executed when the communication cycle is 62.5 μs. |
| Handling | ● When using absolute positioning under pp control when in continuous rotating absolute encoder mode, or when using csp control, set a reachable position (within the range of the Obj.607Bh: “Position range limit” ) to the target position.<br>● When executing a trial run using Set-up Support Software (PANATERM ver.7) , set the communication cycle to 125 μs or more. |

### Err92.0.0 “Encoder data recovery error protection”

| | |
|---|---|
| Primary cause | The internal position information initialization process was not executed normally when in semi-closed control and absolute mode. |
| Handling | ● Keep the encoder power supply voltage at 5 V DC ±5% (4.75 to 5.25 V).<br>This is particularly important when the encoder cables are long.<br>● If the motor cables and encoder cables are bundled together, separate them.<br>● Connect shielding to FG. |

## Err92.1.0 “External scale data recovery error protection”

| | |
|---|---|
| Primary cause | The internal position information initialization process was not executed normally when in full-closed control and absolute mode. |
| Handling | ● Keep the external scale power supply voltage at 5 V DC ±5% (4.75 to 5.25 V).<br>This is particularly important when the external scale connection cable is long.<br>● If the motor cables and external scale connection cable are bundled together, separate them.<br>● Connect shielding to FG.<br>See *“3.2.6 Wiring to Connector X5 (Connecting to External Scale)”* . |

## Err92.3.☐ “Multi-turn data upper limit value disagreement error protection”

- Err92.3.0 to Err92.3.2 “Multi-turn data upper limit value disagreement error protection”

| | |
|---|---|
| Primary cause | In continuous rotating absolute encoder mode, the encoder multi-turn data upper-limit value does not agree with the multi-turn data upper-limit value for the driver parameters. |
| Handling | Check the parameter setup values. |

## Err93.2.0 “Parameter setup error protection 2”

| | |
|---|---|
| Primary cause | The external scale ratio was outside the allowable range. |
| Handling | Check the value set for the parameter, and set it so that it is in the range of 1/40 ≦ External scale ratio ≦ 20480. |

## Err93.3.☐ “External scale connection error protection”

- Err93.3.0 to Err93.3.5 “External scale connection error protection”

| | |
|---|---|
| Primary cause | ● The value set for Pr3.23 “External scale selection” does not match the external scale type for the connected serial communication type. |
| Handling | ● Set Pr3.23 “External scale selection” in accordance with the connected external scale type.<br>● Review the setting of Pr3.23 “External scale selection” . |

## Err93.5.0 “Parameter setup error protection 4”

| | |
|---|---|
| Primary cause | Pr6.102 “Over-travel inhibit release level setup” was set to a value over 0 when Pr5.04 “Over-travel inhibit input setup” was set to a value other than 1. |
| Handling | Check the parameter setup values. |

## Err93.8.0 “Parameter setup error protection 6”

| | |
|---|---|
| Primary cause | ● Set to continuous rotating absolute encoder mode with anything other than a 27-bit or 23-bit resolution absolute encoder.<br>● The absolute home position offset was set to a value exceeding the upper-limit value of the command position in continuous rotating absolute encoder mode.<br>● The upper-limit values for actual position and command position were set to $2^{31}$ or more in continuous rotating absolute encoder mode. |
| Handling | Check the parameter setup values. |

### Err94.3.0 “Homing error protection 2”

| | |
|---|---|
| Primary cause | ● Either positive direction or negative direction over-travel inhibit input (POT or NOT) was turned ON during the return operation to the Z-phase position detected during homing using Z-phase while Pr7.22 “Communication function extended setup 1” :bit 7 = 1 and Pr5.04 “Over-travel inhibit input setup” = 0 or 1 (independent of Pr5.04 for profile position control (pp)).<br>● An error occurred in EEPROM writing of Pr7.120 “Absolute scale offset 1” or Pr7.121 “Absolute scale offset 2” during a homing operation in absolute mode. |
| Handling | ● Increase the distance between the Z-phase and the positive direction over-travel inhibit input (POT)/negative direction over-travel inhibit input (NOT).<br>● After ensuring safety, set Pr7.22:bit 7 “Over-travel inhibit input detection setting during Z-phase homing return operation” = 0 (disabled).<br>● Clear the alarm, then re-run the homing operation.<br>If the alarm still occurs after performing the homing operation again, this product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err95.☐.0 “Motor automatic recognition error protection ☐”

| | |
|---|---|
| Primary cause | The motor and this product do not match. |
| Handling | Replace the motor with one that matches this product. |

### Err96.4.0 “Host controller error protection 3”

| | |
|---|---|
| Primary cause | An error occurred in the host controller of this product. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err96.6.0 “Host controller error protection 5”

| | |
|---|---|
| Primary cause | An error occurred in the host controller of this product. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Err98.☐.0 “Communication hardware error protection ☐”

- Err98.2.0 to Err98.3.0 “Communication hardware error protection ☐”

| | |
|---|---|
| Primary cause | An error occurred in the internal EtherCAT communication peripheral circuit. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

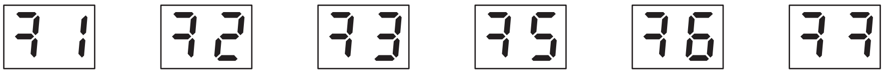
### Err98.5.0 “Hardware self-diagnostic error protection 1”

| | |
|---|---|
| Primary cause | ● The current detector has malfunctioned. |
| Handling | Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Other numbers “Other error protection”

| | |
|---|---|
| Primary cause | ● The control circuit has malfunctioned due to excessive noise, etc.<br>● The self-diagnosis function of this product was started and an error of some kind occurred inside this product. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

### Special 7-segment display “System error protection”

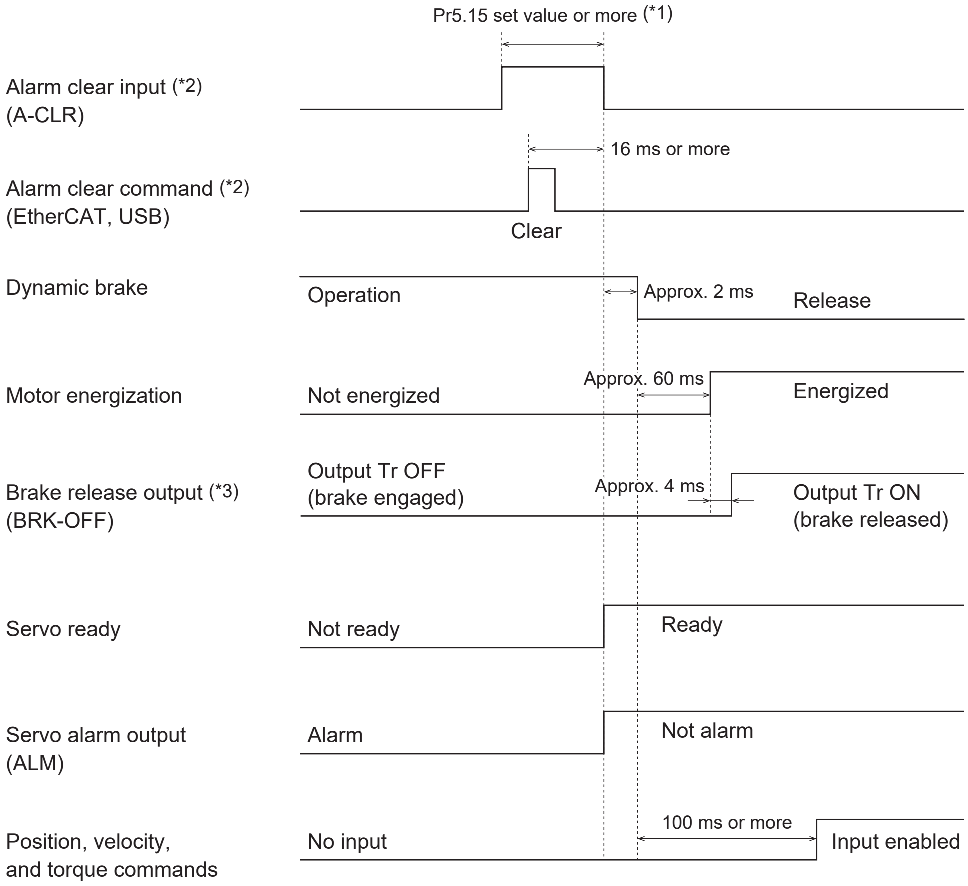
Front panel display: 

For details, see *“3.2.5.5.1 Control Output Signal”* of *“Precautions”* “5”.

| | |
|---|---|
| Primary cause | An error has occurred inside the product. |
| Handling | ● Turn the power supply off and then on again.<br>● If the alarm still occurs after the power is turned on again, the product may be malfunctioning.<br>Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |

## 10.2.4 Timing Chart

The operation timing chart when clearing an alarm (servo-on command state) is shown below.



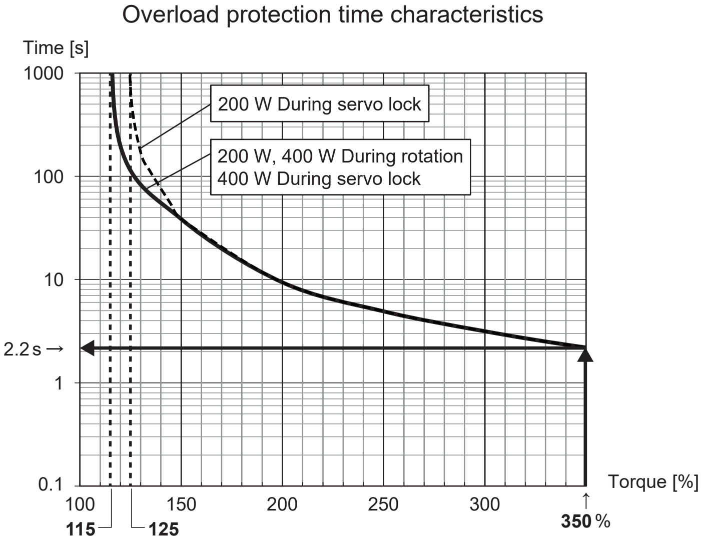
*1 The alarm clear input recognition time is the time set by the Pr5.15 “Control input signal reading setup” setting.

*2 When clearing an alarm from EtherCAT communication or USB communication (set-up support software (PANATERM ver.7)), do so once the alarm clear input (A-CLR) is switched to OFF.

*3 The brake release output (BRK-OFF) is different from the Obj.60FEh: “Digital outputs” set brake command from EtherCAT communication. For details on the set brake command from Obj.60FEh: “Digital outputs” , see *“6.6.8 Motion Common Functions”* .

### 10.2.5 Overload Protection Time Characteristics Confirmation Method

When operating a motor within its instantaneous operating range, use it for less than the time on the overload protection time characteristics curve.



The above figure shows the overload protection time characteristics curve for a 200 W motor. If the motor is instantaneously made by a command (torque limit) from the driver to output 350% torque, which is outside the continuous operating range, protection is engaged after 2.2 seconds in accordance with the overload protection time characteristic curve and operation is stopped.

For the overload protection time characteristics, see *“2.2.5 Overload Protection Time Characteristics (Motor)”* .

Depending on motor operating condition, the value of Pr5.12 “Motor overload level setup” may not match the value of overload load factor when Err16.0.0 “Overload protection” occurs.

Similarly, the values of Pr6.95 “Motor overload warning detection level” and Pr6.96 “Motor overload warning release level” may not match the values of overload load factor when WngA0h “Motor overload warning” occurs.

(Example) When characteristics of the dashed line in the figure above (at 200 W servo lock) is performed, overload load factor may exceed Pr5.12 “Motor overload level setup” when Err16.0.0 “Overload protection” occurs.

## 10.3 Warning Functions

Warning functions generate a warning before a protection function is triggered to alert the operator in advance of a condition, such as an overload.

If use continues in a warning environment, it may stop, reduce life, or failure due to the protection function of the servo drive. Please do not use until the cause of the warning is ruled out.

Warning functions have the following two modes.

- Warning non-latch mode: Mode in which, if the primary cause of the warning is resolved, it is automatically cleared after 1 s and returns to the state before the warning was triggered
- Warning latch mode: Mode in which the warning state is maintained even if the primary cause of the warning is resolved

You can switch between the two modes with Pr6.27 “Warning latch state setup” . The warning state is cleared by the same procedure as used for clearing a protection function alarm. If the primary cause is not resolved, the warning may be cleared but will be detected again.

However, battery warnings are latched on the encoder side. The latch state on the encoder side can be cleared and the warning canceled by clearing the alarm after replacing the battery.

A warning will not be triggered if external alarm clear (A-CLR) is in the ON state.

### 10.3.1 Setup Value

—: None

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 4 | 40 | A | Selection of alarm output 1 | 0 to 32767 | — | Selects the warning that is output with Warning output 1 (WARN1).<br>If this setup value is 0, OR output of all warning outputs will be obtained.<br>If this setup value is 1 or more, see *“10.3.2 List of Warning Functions”* . |
| 4 | 41 | A | Selection of alarm output 2 | 0 to 32767 | — | Select the warning that is output with Warning output 2 (WARN2).<br>If this setup value is 0, OR output of all warning outputs will be obtained.<br>If this setup value is 1 or more, see *“10.3.2 List of Warning Functions”* . |
| 5 | 12 | A | Motor overload level setup | 0 to 500 | % | Sets the motor overload level of effective torque.<br>If this setting value is 0, the motor overload level setup is 115%.<br>Use 0 under normal conditions. Set the level only if using a lower motor overload level.<br>This setting value is restricted to a motor rating of 115%. Values exceeding 115% cannot be set.<br>For details on how to confirm the overload protection time characteristics, see *“10.2.5 Overload Protection Time Characteristics Confirmation Method”* . |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 27 | C | Warning latch state setup | 0 to 3 | — | Sets the warning latch state.<br>General warnings and expanded warnings can be set.<br>● bit 0: Expanded warnings<br>0: Non-latch<br>1: Latch<br>● bit 1: General warnings<br>0: Non-latch<br>1: Latch |
| 6 | 37 | B | Oscillation detecting level | 0 to 1000 | 0.1% | Sets the threshold for oscillation detection.<br>When torque vibration beyond this setting is detected, an oscillation detection warning is activated.<br>When this setup value is 0, this function is disabled and no warning is triggered. |
| 6 | 38 | C | Warning mask setup | -32768 to 32767 | — | Set up the warning detection mask. If the corresponding bit is set to 1, detection of the corresponding warning is disabled. |
| 6 | 39 | C | Warning mask setup 2 | -32768 to 32767 | — | |
| 6 | 47 | R | Function expansion setup 2 | -32768 to 32767 | — | bit 2: Encoder communication error/warning judgment setup<br>0: Standard specification (judges errors and warnings using the system specified value)<br>1: Relaxed specification (judges errors and warnings using twice the system specified value) |
| 6 | 95 | A | Motor overload warning detection level | 0 to 114 | % | Set the threshold for detecting a warning when the overload load factor has increased.<br>Set the overload load factor.<br>When set to 0, a motor overload warning will be detected according to past conditions (85 % of motor overload level).<br>Motor overload warning detection will also be performed according to past conditions (85 % of motor overload level) when this is set to anything other than “Pr6.96 ≤ Pr6.95 < (motor overload level)”. |
| 6 | 96 | A | Motor overload warning release level | 0 to 114 | % | Sets the threshold for releasing the warning when the load factor decreases from when the motor overload warning was triggered.<br>Set the overload load factor.<br>When set to 0, a motor overload warning will be detected according to past conditions (85 % of motor overload level).<br>Motor overload warning detection will also be performed according to past conditions (85 % of motor overload level) when this is set to anything other than “Pr6.96 ≤ Pr6.95 < (motor overload level)”. |
| 6 | 97 | B | Function expansion setup 3 | -2147483648 to 2147483647 | — | bit 1: Deterioration Diagnosis Warning Function<br>0: Disabled<br>1: Enabled<br>bit 14: Over-travel inhibit warning<br>0: Disabled<br>1: Enabled |

| Class | No. | Attribute (*1) | Parameter name | Setting range | Unit | Function |
|---|---|---|---|---|---|---|
| 6 | 104 | B | Open-phase monitoring setup | 0 to 3 | – | Enables and disables open-phase monitoring setup.<br>0: Automatic<br>1: Warning enabled<br>2: Alarm enabled<br>3: Disabled |
| 6 | 126 | C | Warning 2 mask setup | -2147483648 to 2147483647 | – | Set up the warning detection mask. If the corresponding bit is set to 1, detection of the corresponding warning is disabled. |
| 6 | 127 | C | Warning 3 mask setup | -2147483648 to 2147483647 | % | Set up the warning detection mask. If the corresponding bit is set to 1, detection of the corresponding warning is disabled. |
| 7 | 14 | C | Main power off warning detection time | 0 to 2000 | ms | Set the time until the main power off warning is detected when there is a continuous interruption to the main power supply.<br>Warning detection is disabled when the setup value is 0 to 9, or 2000. |
| 7 | 99 | B | EtherCAT function expansion setup 6 | -32768 to 32767 | – | bit 0: Enable/disable FFT execution while EtherCAT communication is established<br>0: Disabled<br>1: Enabled |

*1 For attributes, see *“6.2 Object Dictionary List”* .

## 10.3.2 List of Warning Functions

Warning functions have the following two types.

General warnings: Warnings common to the A7 family

Expanded warnings: Warnings unique to the MINAS A7B Series

A list of warning functions is shown below.

## General warnings

| Warning No. (hex.) | Warning name | Description | Warning latch | Output setting | Warning mask |
|---|---|---|---|---|---|
| | | | Pr6.27 (*1) | Pr4.40, Pr4.41 (*2) | Pr6.38/ Pr6.39 supported bit (*3) |
| A0 | Motor overload warning | The warning detection specifications vary depending on the values of Pr6.95 “Motor overload warning detection level” and Pr6.96 “Motor overload warning release level” . For details, see the table below.<br>The motor overload warning detection specifications can be switched to the expanded specifications with the settings for Pr6.95 and Pr6.96. | ○ | 1 | Pr6.38 bit 7 |

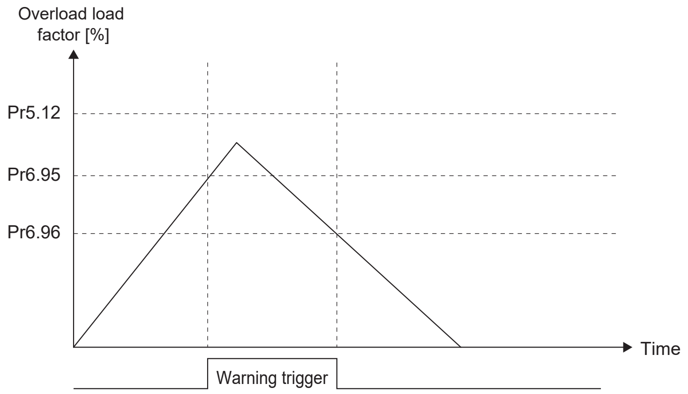
- Details of Warning No. A0 (Motor overload warning)

| Pr6.95 | Pr6.96 | Size relationship between Pr6.95 and Pr6.96 | Warning detection specifications | Warning release specifications | Remarks |
|---|---|---|---|---|---|
| Other than 0 | Other than 0 | Pr6.95 ≥ Pr6.96 | Load factor ≥ Pr6.95 | Load factor < Pr6.96 | Expanded specification |
| | | Pr6.95 < Pr6.96 | Load factor is ≥ 85% of protection level | Load factor is < 85% of protection level | Do not set. |
| | 0 | — | | | |
| 0 | Other than 0 | | | | |
| | 0 | | | | Conventional specifications |

- Details on expanded specifications

  The warning latch function is disabled in the expanded specifications.

  - When Pr6.95 “Motor overload warning detection level” and Pr6.96 “Motor overload warning release level” are anything other than 0 and Pr6.96 ≤ Pr6.95 and Pr6.95 < Pr5.12 “Motor overload level setup”

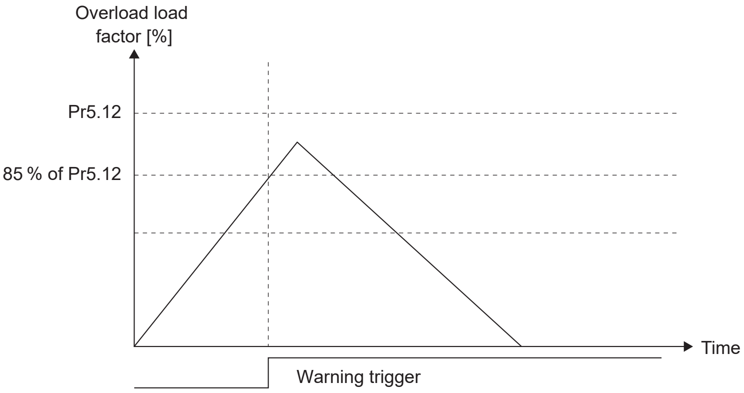


<table>
<tr><th rowspan="2">Warn-ing No. (hex.)</th><th rowspan="2">Warning name</th><th rowspan="2">Description</th><th>Warning latch</th><th>Output setting</th><th>Warning mask</th></tr>
<tr><th>Pr6.27 (*1)</th><th>Pr4.40, Pr4.41 (*2)</th><th>Pr6.38/ Pr6.39 supported bit (*3)</th></tr>
<tr><td colspan="6">

- Details on conventional specifications

In the conventional specifications, the warning latch function is dependent on the setting for Pr6.27 “Warning latch state setup” .

- Under conditions other than expanded functions



When the warning latch function setting is enabled, if the setting for Pr6.95 or Pr6.96 is changed to switch the motor overload warning detection specification to the expanded specification after a motor overload warning is triggered, latched motor overload warnings will be cleared because the warning latch function is disabled.

</td></tr>
<tr><td>A1</td><td>Over-regeneration warning</td><td>The regenerative load factor exceeded 85% of the protection level.</td><td>○</td><td>2</td><td>Pr6.38<br>bit 5</td></tr>
<tr><td>A2</td><td>Battery warning</td><td>Battery voltage is 3.2 V or less.<br>The battery warning will not be detected when Pr0.15 = 1 (incremental mode) or Pr0.15 = 3 (single-turn absolute mode) with an absolute encoder (battery backup), or when a batteryless absolute encoder is used.</td><td>Fixed latch</td><td>3</td><td>Pr6.38<br>bit 0</td></tr>
<tr><td>A3</td><td>Fan lock warning</td><td>Fan stopped status continued for 1 second.</td><td>○</td><td>4</td><td>Pr6.38<br>bit 6</td></tr>
<tr><td>A4</td><td>Encoder communication warning</td><td>The number of consecutive occurrences of encoder communication errors exceeded the standard value.</td><td>○</td><td>5</td><td>Pr6.38<br>bit 4</td></tr>
<tr><td>A5</td><td>Encoder overheat warning</td><td>The encoder temperature exceeded the standard value.<br>Take measures such as lowering the ambient temperature, reducing the load, and/or reviewing heat dissipation.</td><td>○</td><td>6</td><td>Pr6.38<br>bit 3</td></tr>
<tr><td>A6</td><td>Oscillation detection warning</td><td>Oscillation was detected.</td><td>○</td><td>7</td><td>Pr6.38<br>bit 13</td></tr>
<tr><td>A7</td><td>Lifetime detection warning</td><td>The remaining life of the capacitor or fan was below the specified level.</td><td>Fixed latch</td><td>8</td><td>Pr6.38<br>bit 2</td></tr>
<tr><td>A8</td><td>External scale error warning</td><td>An external scale detected a warning.</td><td>○</td><td>9</td><td>Pr6.38<br>bit 8</td></tr>
<tr><td>A9</td><td>External scale communication warning</td><td>The number of consecutive occurrences of external scale communication errors exceeded the standard value.</td><td>○</td><td>10</td><td>Pr6.38<br>bit 14</td></tr>
<tr><td>AB</td><td>Fan speed reduction warning</td><td>Low fan speed detected.</td><td>○</td><td>43</td><td>Pr6.126<br>bit 9</td></tr>
<tr><td>E1</td><td>Driver overload warning</td><td>ver derating monitor is more than 100 %.</td><td>○</td><td>44</td><td>Pr6.126<br>bit 10</td></tr>
</table>

| Warning No. (hex.) | Warning name | Description | Warning latch | Output setting | Warning mask |
|---|---|---|---|---|---|
| | | | Pr6.27 (*1) | Pr4.40, Pr4.41 (*2) | Pr6.38/ Pr6.39 supported bit (*3) |
| E2 | Lifetime detection warning 2 | The remaining life of the nonvolatile memory is below the specified value. | ○ | 45 | Pr6.126 bit 11 |

*1 The “○” part can be switched between non-latch mode (latched for 1 s) and latched mode using Pr6.27 “Warning latch state setup” . Battery warning and lifetime detection warning are fixed in latch mode and cannot be switched.

*2 The warning that is output in warning output signal 1 (WARN1) and signal 2 (WARN2) is selected using Pr4.40 “Selection of alarm output 1” and Pr4.41 “Selection of alarm output 2” . In case of setting value 0, OR output of all warnings will be obtained. In addition, do not use the setup values other than those listed in the above table.

*3 Each warning detection can be disabled with Pr6.38 “Warning mask setup” , Pr6.39 “Warning mask setup 2” and Pr6.126 “Warning 2 mask setup” .

Supported bits are indicated in the table. Warning detection is disabled by setting the corresponding bit to 1.

For expanded warnings, it is possible to disable warning detection with the respective setting parameters.

## ■ Expanded warnings

| Warning No. (hex.) | Warning name | Description | Warning latch | Output setting | Warning mask |
|---|---|---|---|---|---|
| | | | Pr6.27 (*1) | Pr4.40, Pr4.41 (*2) | Pr6.38/ Pr6.39 supported bit (*3) |
| C3 | Main power off warning | When the setting for Pr7.14 “Main power off warning detection time” is 10 to 1999, power is instantaneously interrupted between L1 and L3 for at least the time set with Pr7.14. | ○ | 14 | Pr6.38 bit 12 |
| CA | Main power phase loss warning | An open phase was detected in the main power supply when Pr6.104 “Open-phase monitoring setup” had warnings enabled. | ○ | 42 | Pr6.126 bit 8 |
| D2 | Set-up Support Software (PANATERM ver.7) command execution warning | Operation commands (trial run, frequency characteristics analysis function (FFT function), Config, etc.) by Set-up Support Software (PANATERM ver.7) were executed when EtherCAT communication was established with bit 0 of Pr7.99 “Communication function extended setup 6” set to 1. | ○ | 30 | Pr6.39 bit 8 |
| D3 | Over-travel inhibit warning | The over-travel inhibit is now disabled.<br>Disabled when Pr6.97 “Function expansion setup 3” :bit 14 = 0.<br>Occurs only if the setting Pr5.04 “Over-travel inhibit input setup” = 1 is applied. | ○ | 31 | Pr6.39 bit 9 |

*1 The “○” part can be switched between non-latch mode (latched for 1 s) and latched mode using Pr6.27 “Warning latch state setup” . Battery warning and lifetime detection warning are fixed in latch mode and cannot be switched.

*2 The warning that is output in warning output signal 1 (WARN1) and signal 2 (WARN2) is selected using Pr4.40 “Selection of alarm output 1” and Pr4.41 “Selection of alarm output 2” . In case of setting value 0, OR output of all warnings will be obtained. In addition, do not use the setup values other than those listed in the above table.

*3 Each warning detection can be disabled with Pr6.38 “Warning mask setup” , Pr6.39 “Warning mask setup 2” and Pr6.126 “Warning 2 mask setup” .

Supported bits are indicated in the table. Warning detection is disabled by setting the corresponding bit to 1.

For expanded warnings, it is possible to disable warning detection with the respective setting parameters.

## 10.3.3 Warning Function Details

Details about expanded warnings are shown below.

For general warnings among the warning functions, check the warning names and warning descriptions in the table in *"10.3.2 List of Warning Functions"* and check the corresponding parts.

### WngC3h "Main power off warning"

| | |
|---|---|
| Primary cause | When the setting for Pr7.14 "Main power off warning detection time" is 10 to 1999, power is instantaneously interrupted between L1 and L3 for at least the time set with Pr7.14. |
| Detected ESM state | No |
| Detected synchronous mode | No |
| ESM state after detection | No |
| Handling | Measure the voltage in the lines between connectors (L1, L2, L3) and take the following actions.<br>● Increase the power supply voltage capacity, change the power supply, eliminate whatever caused the electromagnetic contactor in the main power supply to drop, then turn the power back on.<br>● Check the setting for Pr7.14 "Main power off warning detection time" and set it properly for each phase of the power supply.<br>● Increase the power supply capacity.<br>For information on power supply capacity, see *"1.8.2.2 List of Peripheral Devices"* .<br>● Properly connect each phase (L1, L2, L3) of the power supply.<br>Use L1, L3 for single phase 100 V and single phase 200 V.<br>● Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |
| Method of warning status clearing after the cause is resolved | ● Clear the alarm after disabling this warning.<br>● Reboot if there is a power reset or if a reset command is executed. |

### WngCAh "Main power phase loss warning"

| | |
|---|---|
| Primary cause | An open phase was detected in the main power supply when Pr6.104 "Open-phase monitoring setup" had warnings enabled. |
| Detected ESM state | No |
| Detected synchronous mode | No |
| ESM state after detection | No |
| Handling | ● Check the connection of the main power input line.<br>● Measure the line voltage between connectors (L1, L2, L3) and eliminate line voltage imbalance.<br>● Confirm that the line voltage between connectors (L1, L2, L3) is the specified value.<br>● Replace the servo driver with a new one.<br>Return the servo driver in which the alarm occurred to the dealer for examination (repair). |
| Method of warning status clearing after the cause is resolved | ● Clear the alarm after disabling this warning.<br>● Reboot if there is a power reset or if a reset command is executed. |

### WngD2h "Set-up Support Software (PANATERM ver.7) command execution warning"

This warning notifies that an operation command (trial run, frequency characteristics analysis function (FFT function), Z-phase search, One Minute TUNING) or Config execution was run by Set-up Support Software (PANATERM ver.7) while EtherCAT communication is established when Obj.3799h:00h "Communication function extended setup 6" :bit 0 is 1. This warning is not generated when a device error is detected.

| | |
|---|---|
| Primary cause | Operation commands (trial run, frequency characteristics analysis function (FFT function), etc.) by Set-up Support Software (PANATERM ver.7) were executed or Config was executed when EtherCAT communication was established with Pr7.99 "Communication function extended setup 6" :bit 0 set to 1. |
| Detected ESM state | PreOP, SafeOP, OP |
| Detected synchronous mode | DC, FreeRun, SM2 |
| ESM state after detection | Remains in the current ESM state. |
| Handling | Stop the operating command through Set-up Support Software (PANATERM ver.7) . |
| Method of warning status clearing after the cause is resolved | For details on clearing warnings, see *"10.2 Protection Functions"* . |

### WngD3h "Over-travel inhibit warning"

| | |
|---|---|
| Primary cause | The over-travel inhibit is now disabled. |
| Detected ESM state | No |
| Detected synchronous mode | No |
| ESM state after detection | No |
| Handling | If the over-travel inhibit warning occurs unintentionally, perform the following process.<br>● Check if the input is not an input that causes an over-travel inhibit condition.<br>● Check the POT and NOT assignment settings.<br>● Check Pr5.04 "Over-travel inhibit input setup" .<br>● Set Pr6.97 "Function expansion setup 3" :bit 14 to 0 to disable the over-travel inhibit warning that occurs in the over-travel inhibit state. |
| Method of warning status clearing after the cause is resolved | ● Clear the alarm after disabling this warning.<br>● Reboot if there is a power reset or if a reset command is executed. |

## 10.4 Timestamp Function

This function adds the time when the alarm occurred to the alarm supplementary information, and adds the time of measurement to the waveform information measured by the waveform measurement function using Set-up Support Software (PANATERM ver.7) .

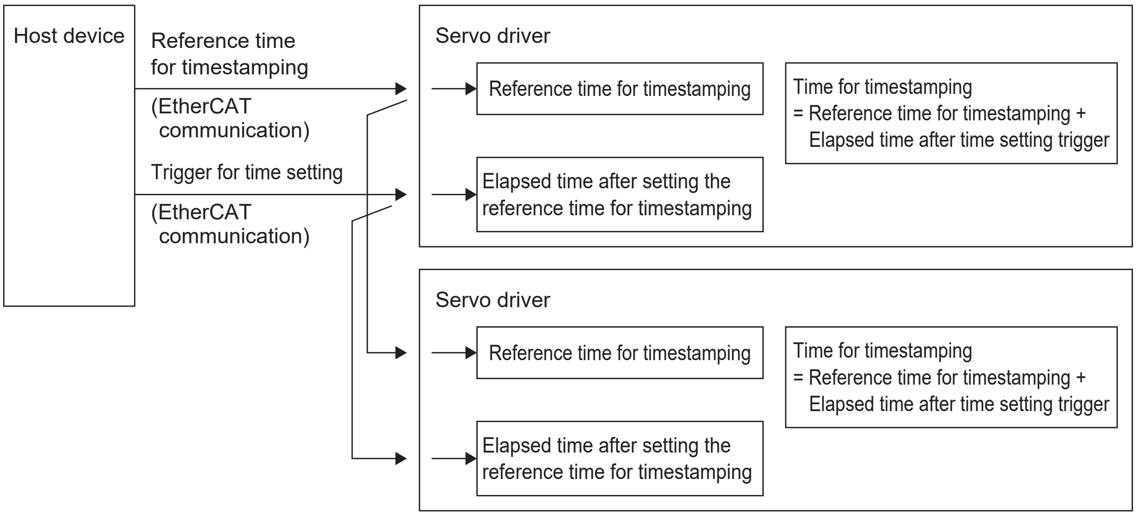
### ■ Operational conditions

| Item | Operational conditions |
|---|---|
| Control mode | ● All control modes |

### ■ Operation

- Timestamp time
  - When used in DC synchronous mode, SM2 synchronous mode, or FreeRun mode

    Timestamping is enabled when the time setting trigger (Obj.60FEh: “Digital outputs” :bit 28 “Timestamp reference time reset” ) is set to 1 after setting the timestamp reference time (Obj.430Eh:01h “Timestamp reference time setting 1” and Obj.430Eh:02h “Timestamp reference time setting 2” ), and the elapsed time from the timestamp reference time is displayed in nanosecond increments.



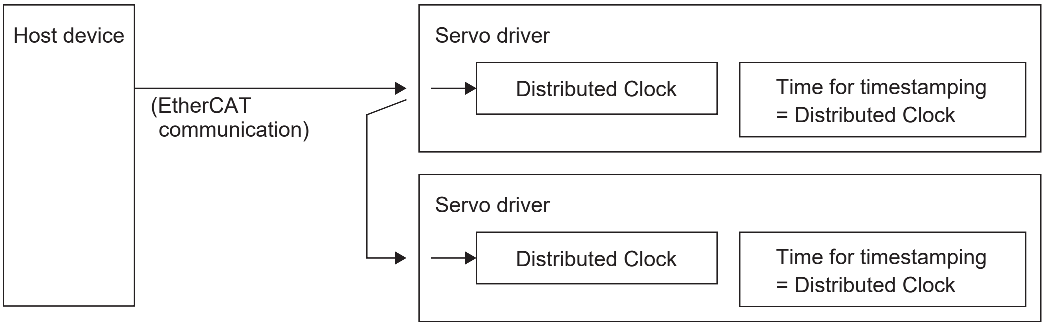
The reference time for timestamping should be set to the elapsed time in ns units, starting at 0:00:0:0 on January 1, 2000.

(Setting example) Set 0A2E59AF97450000h (= 733622400000000000) for April 1, 2023, 00:00:00.

If the timestamp reference time is set near the maximum value (e.g., year 2584) and the count-up value reaches the maximum value (FFFFFFFFFFFFFFFFh), counting up is stopped. The timestamp will display the maximum value.

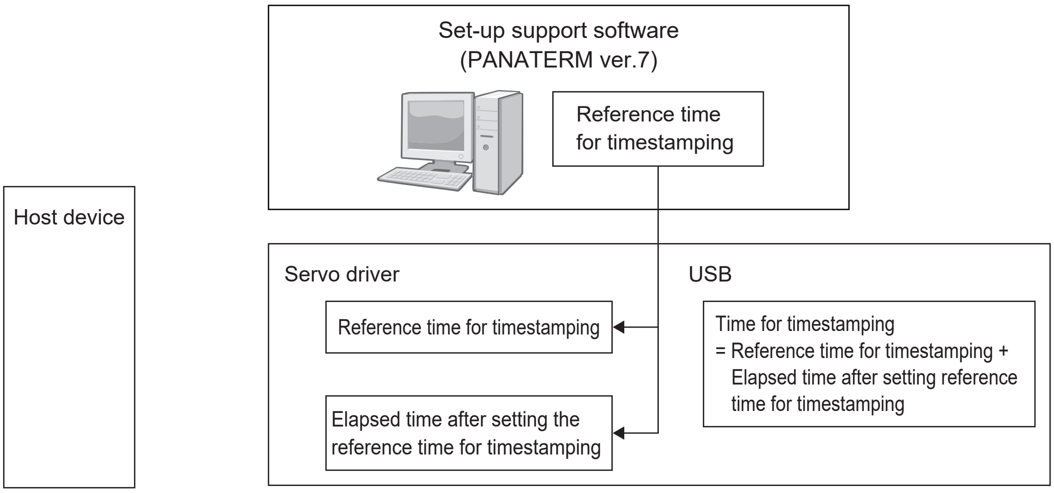
If the timestamp reference time is not sent from the host device in SM2 synchronous mode or FreeRun mode, the time for timestamp is fixed at 0000000000000000h.

When the timestamp reference time is not sent in DC synchronous mode, or when the timestamp reference is set but the trigger information for time setting is not sent, the timestamp time displays the value of “Distributed Clock” inside the servo driver.



- When used with Set-up Support Software (PANATERM ver.7)

  Timestamps are enabled when "Timestamp Reference Time" is set. The elapsed time is displayed in nanosecond increments from the timestamp reference time.



- ● Time synchronization between multiple axes

  This product synchronizes each axis by receiving time synchronization information (timestamp reference time and time setting trigger) from the host device. Multiple axes must be synchronized via a network connection (EtherCAT). In FreeRun mode, synchronization between axes is not possible.

  Implement the time setting trigger after the ESM status of each axis becomes OP.

  When Set-up Support Software (PANATERM ver.7) is used, settings are made for each individual unit and the time information is not synchronized between axes, resulting in errors in time information.

- ● Timestamps for the waveform measurement function with Set-up Support Software (PANATERM ver.7)

  When measuring motor operating waveforms and displaying the results in a waveform graph, the trigger time for waveform measurement can be displayed. If triggers for waveform measurement were not set, the waveform measurement start time is displayed.

  For details on the waveform measurement function, see Set-up Support Software (PANATERM ver.7) Operating Manual.

# 11 Troubleshooting

## 11.1 Overview

The following is a list of solutions to malfunctions or errors that may occur with the servo driver and servo motor.

For information on Set-up Support Software (PANATERM ver.7) , see *“12.1 Set-up Support Software (PANATERM ver.7)”* .

## 11.2 Motor Does Not Rotate

| Classification | Cause | Item(s) to check | Action(s) to take |
|---|---|---|---|
| Parameters | Control mode setup is not correct. | Is the wrong control mode currently being used as the monitor mode in the Set-up Support Software (PANATERM ver.7) ? | Reset Pr0.01 “Control mode setup” .<br>See *“4.1 Network Outline”* . |
| | Command pulse division/ multiplication setup is not correct (Position). | Does the motor move the expected amount relative to the command pulse input? | Check the settings for Obj.608Fh:00h “Highest sub-index supported” , Obj.6091h:00h “Number of entries” and Obj.6092h:00h “Highest sub-index supported” again.<br>See *“7.2.3 Electronic Gear Function”* . |
| Wiring | The connector X4 positive direction over-travel inhibit input (POT) and negative direction over-travel inhibit input (NOT) have been released. | Are the Pin No. corresponding to the positive direction over-travel inhibit input (POT) and negative direction over-travel inhibit input (NOT) in the Set-up Support Software (PANATERM ver.7) monitor mode in “A” state? | ● Check the wiring of the input signals for the positive direction over-travel inhibit input (POT) and negative direction over-travel inhibit input (NOT).<br>● Set Pr5.04 “Over-travel inhibit input setup” to 1 (disable) and reset the power supply. |
| Installation | Main power is shut off. | Is the Pin No. corresponding to S-RDY in the monitor mode in the Set-up Support Software (PANATERM ver.7) in “–” state? | Check the wiring and voltage of the main power to the driver (L1, L2, L3). |
| | The motor output axis drags.<br>It does not turn. | ● Check that you can turn the motor axis, after turning off the driver power and separating it from the machine.<br>● Check that you can turn the motor axis while applying 24 V DC to the brake in case of the motor with holding brake. | If you cannot turn the motor axis, consult with the dealer where you purchased the motor for repair. |

## 11.3 Unstable Rotation (Not Smooth)

| Classification | Cause | Handling |
|---|---|---|
| Tuning | Gain is poorly tuned. | ● Increase the Pr1.01 “1st velocity loop gain” set values.<br>● Enter Pr1.04 “1st torque filter time constant” and increase the set value of Pr1.01 “1st velocity loop gain” again.<br>See Operating Instructions (Tuning). |

## 11.4 Positioning Accuracy Is Poor

| Classification | Cause | Handling |
|---|---|---|
| System | The positioning command is not correct (Amount of command pulse). | Repeatedly go back and forth the same distance and count the feedback pulses with the Set-up Support Software (PANATERM ver.7) monitor function.<br>If the same value is not returned, carefully examine the host device. |
| Tuning | Position loop gain is small. | Check the amount of position deviation with the Set-up Support Software (PANATERM ver.7) monitor function.<br>Increase the set value for Pr1.00 “1st gain of position loop” within a range that does not cause oscillation and check again.<br>See Operating Instructions (Tuning). |
| Parameters | Setup of the positioning complete (In-position) range is large. | Decrease the set value for Pr4.31 “Positioning complete (In-position) range” to within a range where chattering with the complete signal does not occur.<br>See *“7.3.4 Positioning Complete Output (INP/INP2) Function”* . |
| | Division/multiplication setup is not correct. | Check if the repetition accuracy is the same. |
| | The speed loop gain will switch to proportional action when the motor is stopped. | Set Pr1.02 “1st velocity loop integration time constant” and Pr1.07 “2nd velocity loop integration time constant” to 9999 or less. |
| Installation | Load inertia is high. | Use the Set-up Support Software (PANATERM ver.7) to check the overshoot in the waveform graphic when the motor is stopped.<br>If this is not fixed by tuning the gain, increase the motor and driver capacity. |

## 11.5 Home Position Misalignment

| Classification | Cause | Handling |
|---|---|---|
| System | Z-phase is not detected when finding home. | ● Check that the Z-phase aligns to the center of the proximity switch.<br>● Perform homing correctly in coordination with the host device. |
| | Home creep speed is fast. | ● Decrease the homing speed in proximity to home.<br>● Lengthen the home sensor. |
| Wiring | Chattering in output from the near home sensor (proximity switch sensor). | Use an oscilloscope to check the proximity switch sensor input signal on the host device.<br>Carefully examine the wiring near the proximity switch and take measures to reduce noise, etc. |
| | Noise accumulates in the encoder cable. | Take measures such as reducing noise (install noise filter or insert ferrite core), shield treatment of I/F cables, using twisted pair wires or separating power and signal cables. |

## 11.6 Abnormal Noise or Vibration from Motor

| Classification | Cause | Handling |
|---|---|---|
| Adjustment | Gain setup is large. | Lower the gain by reducing the settings for Pr1.01 “1st velocity loop gain” , Pr1.06 “2nd velocity loop gain” , Pr1.00 “1st gain of position loop” and Pr1.05 “2nd gain of position loop” .<br>See Operating Instructions (Tuning) |
| Installation | Resonance of the machine and the motor. | ● Set Pr1.04 “1st torque filter time constant” and Pr1.09 “2nd torque filter time constant” and readjust.<br>● Use the Set-up Support Software (PANATERM ver.7) frequency characteristics analysis (FFT function) to see whether there is mechanical resonance.<br>● If there is resonance, set notch frequency Pr2.01 “1st notch frequency” , Pr2.04 “2nd notch frequency” , Pr2.07 “3rd notch frequency” and Pr2.10 “4th notch frequency” .<br>See Operating Instructions (Tuning). |
| | Motor bearing abnormality. | ● Drive the motor under no load and check for noise and vibration near the bearings.<br>● Replace the motor with a new one and check.<br>● Return the motor that generated the error to the vendor for examination (repair). |
| | Electromagnetic sound, gear noise, rubbing noise at brake engagement, hub noise or rubbing noise from encoder. | ● Drive the motor under no load.<br>● Replace the motor with a new one and check.<br>● Return the motor that generated the error to the vendor for examination (repair). |

## 11.7 Undershoot, Overshoot, Motor Overheating (Motor Burnout)

| Classification | Cause | Handling |
|---|---|---|
| Adjustment | Gain is poorly adjusted. | Check the waveform graphic in the Set-up Support Software (PANATERM ver.7) or monitor mode to make the correct gain adjustment.<br>See Operating Instructions (Tuning) |
| Installation | Load inertia is high. | ● Check the waveform graphic in the Set-up Support Software (PANATERM ver.7) or monitor mode to make the correct gain adjustment.<br>● Increase the motor and driver capacity and decrease the inertia ratio.<br>● Use a decelerator. |
| | Looseness or slip in the equipment (machinery). | Carefully examine components that are mounted to the equipment (machinery). |
| | Ambient temperature, environment. | Reduce the temperature by installing a cooling fan if the temperature of the ambient environment exceeds the specified value. |
| | Stalled cooling fan, dirt in fan ventilation duct. | ● Inspect the equipment and driver cooling fans.<br>● Request repair if the driver cooling fan needs to be replaced. |
| | Failure of motor bearing. | ● Turn off the power and manually turn the motor shafts to check for a rumbling noise.<br>● Replace the motor with a new one if there is a rumbling noise.<br>● Return the motor that generated the error to the vendor for examination (repair). |
| | Holding brake left engaged (forgot to release brake). | ● Check the voltage at the holding brake terminals.<br>● Apply power (24 V DC) to release the holding brake. |
| | Motor failure (Oil, water or other). | Avoid high temperature, high humidity locations and atmospheres full of oil, dust or iron powder. |
| | Motor has been turned by external force while dynamic brake was engaged. | Check the running pattern, working condition and operating status.<br>Do not use external force to rotate the motor. |

## 11.8 Number of Rotations Does Not Reach Set Velocity, High or Low Amount of Rotation (Travel)

| Classification | Cause | Handling |
|---|---|---|
| Adjustment | Position loop gain is low. | Set Pr1.00 “1st gain of position loop” and Pr1.05 “2nd gain of position loop” to approximately 1000.<br>See Operating Instructions (Tuning) |
| | Unsuitable division/multiplication. | Review the set values for Obj.608Fh:00h “Highest sub-index supported” , Obj.6091h:00h “Number of entries” and Obj.6092h:00h “Highest sub-index supported” and set the correct values.<br>See *“7.2.3 Electronic Gear Function”* |

## 11.9 Parameter Returns to Previous Setup Value

| Classification | Cause | Handling |
|---|---|---|
| Parameters | Parameters are not being written to EEPROM before the driver power is turned off. | For parameter attributes, see *“6.2 Object Dictionary List”* . |

## 11.10 Communication Not Established

| Classification | Cause | Item(s) to check | Action(s) to take |
|---|---|---|---|
| Wiring | Network cable is broken. | Is either of the [L/A IN] or [L/A OUT] network status LEDs not lit? | If one is out, check the network cable connected to the [L/A IN] or [L/A OUT] connector on the servo driver to see if there is a problem such as a break or bad contact, then reconnect it.<br>See *“3.4.4 EtherCAT Indicators”* . |
| | | Was Err80.4.0 “PDO watchdog error protection” triggered? | If [L/A IN] or [L/A OUT] are lit green when the status is checked, check the connecting cable to the servo driver that triggered Err80.4.0 “PDO watchdog error protection” for the following.<br>● Check the cable for problems such as a break or a bad contact, then reconnect it.<br>● Check whether there is excessive noise on the EtherCAT communication cable. |

# 12 References

## 12.1 Set-up Support Software (PANATERM ver.7)

### 12.1.1 Overview

Connecting a computer with the Set-up Support Software (PANATERM ver.7) installed with this product enables simple procedures including monitoring of parameter settings and control status, set-up support and device analysis.

Set-up Support Software (PANATERM ver.7) is compatible with the following functions.

- USB communication
- Reading and writing servo parameters
- Reading and writing objects
- Status monitoring inside the driver and of input/output terminals
- Alarm detail display, history display, and clearing
- Graphic display of motor operation waveforms
- Trial run, frequency characteristics analysis function (FFT function)

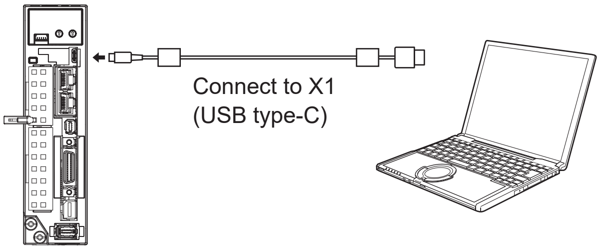
Etc.

For details on Set-up Support Software (PANATERM ver.7) , see Set-up Support Software (PANATERM ver.7) Operating Manual.

Install the Set-up Support Software (PANATERM ver.7) to the computer after downloading it from the Panasonic website. We do not have CD-ROMs or other media available for distribution.

### 12.1.2 Connections

#### 12.1.2.1 When Connecting via USB Cable



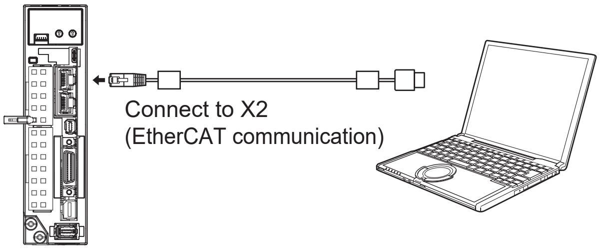
- USB cables

  Use a USB Type-C cable for the connector on the servo driver side.

  Use a compatible connector for the PC specifications on the PC side.

  To reduce the effects of noise, we recommend installing ferrite cores at both ends of the cable. For information on ferrite cores, see *“12.4.3 Ferrite Core”* .

#### 12.1.2.2 When Connecting via EtherCAT Communication Cable



- EtherCAT Communication Cables

  Use an RJ45 connector for the connector on the servo driver side.

  For the EtherCAT communication cables, be sure to use shielded twisted pair cables (STP) compatible with CAT5e of TIA/EIA-568B or higher.

  If both ends of the shield are not grounded, EMC characteristics will degrade.

  When attaching the connector plug to each end of the cables, ensure that the shielded wire of the cable is connected to the metal shell of the plug.

### 12.1.2.2.1 Network Settings for EoE Communication

This section describes the connection and network settings for EoE communication between the MINAS A7B Series and the main device on the EtherCAT network using the EoE function.

For details on the EoE function, see *“4.2.9 Ethernet over EtherCAT (EoE) Function”* .

Specific setup methods will depend on the connection configuration of the devices used.

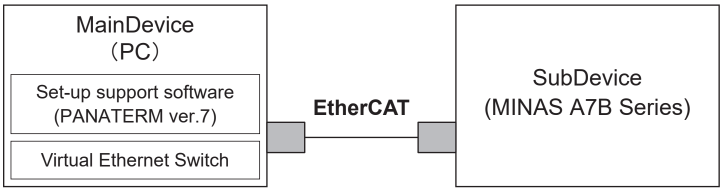
#### 12.1.2.2.1.1 Configuring Device Connections

There are two possible types of connection configurations for EoE communication.

1 When the main device and the Set-up Support Software (PANATERM ver.7) are running on the same PC

Requests from the Set-up Support Software (PANATERM ver.7) are converted into an EoE datagram within the main device and transmitted to the sub device via EtherCAT communication.

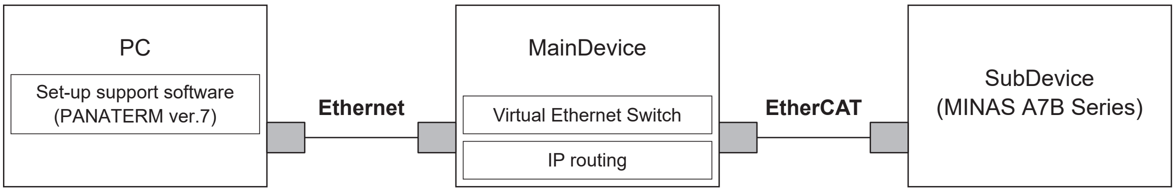
For methods of setting up this connection configuration, see *“When the main device and the Set-up Support Software (PANATERM ver.7) are running on the same PC”* .



2 When the main device is running on a different PC than the Set-up Support Software (PANATERM ver.7)

Requests from the Set-up Support Software (PANATERM ver.7) are first transmitted to the main device via Ethernet communication. Ethernet data addressed from the sub device is converted into an EoE datagram within the main device and transmitted to the sub device via EtherCAT communication.

For methods of setting up this connection configuration, see *“When the main device is running on a different PC than the Set-up Support Software (PANATERM ver.7) ”* .



#### 12.1.2.2.1.2 Configuring Network Settings

This section describes how to set up network settings for each connection configuration when performing EoE communication.

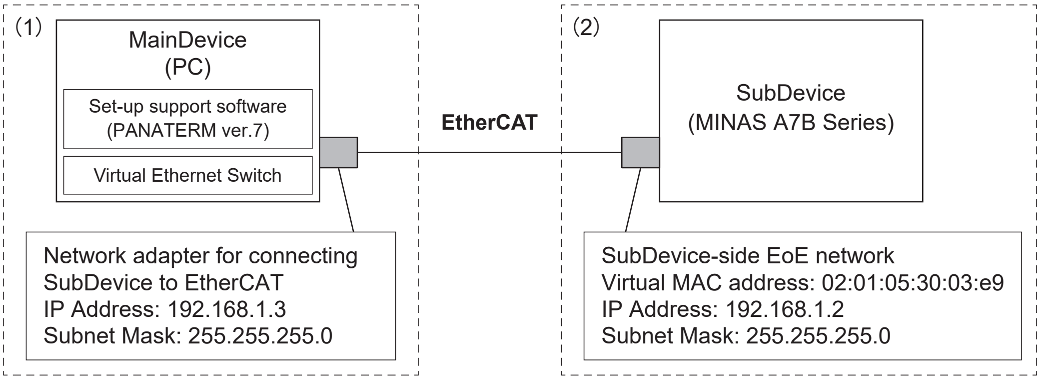
The following shows an example setup method.

Note that specific setup methods will vary depending on the devices and OS used.

### When the main device and the Set-up Support Software (PANATERM ver.7) are running on the same PC

The following shows an example of network settings for each device (main and sub device) when the main device and the Set-up Support Software (PANATERM ver.7) are running on the same PC.

The following setup procedure shows steps based on this setup example.



1 Example of main device side setting

- IP address settings

  Set IP address information for the network adapter that connects the sub device to EtherCAT.

  From the network settings screen on the OS of the main device, set the IP address and subnet mask as follows.

  IP address: 192.168.1.3

  Subnet mask: 255.255.255.0

  There is no need to set a default gateway.

- EoE settings

  Configure settings for the main device side to use the EoE function.

  Enable the virtual Ethernet switch function on the main device and the connection to the TCP/IP stack in the PC’s OS.

  This setting enables Ethernet data generated by the Set-up Support Software (PANATERM ver.7) to be sent to the sub device side via EoE.

2 Sub device side setting example

- IP address settings

  On the main device, set the IP address, subnet mask, and virtual MAC address of the sub device to be connected to the main device.

  The EoE function on the sub device side will be enabled once these settings are complete.

  When setting the IP address, set an address in the same subnet as the IP address set in ““1” Example of main device side setting” as shown below.

  Virtual MAC address: 02:01:05:30:03:e9

  IP address: 192.168.1.2

  Subnet mask: 255.255.255.0

  There is no need to set a default gateway.

  The IP address shown above is only an example. If connecting multiple sub devices, ensure that there are no duplicate IP addresses.

**— Precautions —**

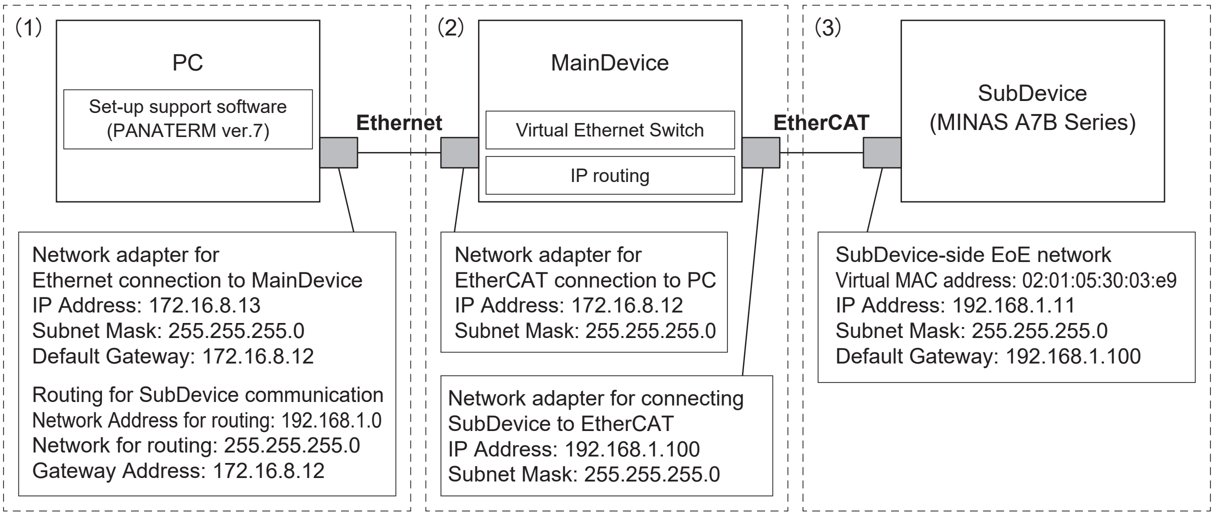
- Once enabled, the EoE function on the sub device side cannot be disabled by operation from the main device or sub device. The sub device must be restarted in order to disable the EoE function on the sub device side. Therefore, if EoE communication will not be used, do not enable the EoE function on the sub device side.

- If you want to communicate without using the EoE function while the EoE function is still enabled on the sub device side, disable the virtual Ethernet switch function on the main device.

### When the main device is running on a different PC than the Set-up Support Software (PANATERM ver.7)

The following shows an example of network settings for each device when the main device is running on a different PC than the Set-up Support Software (PANATERM ver.7) .

The following setup procedure shows steps based on this setup example.



1 Example PC setup

- IP address settings

  Set the IP address information for the network adapter connected to the main device via Ethernet.

  From the network settings screen on the PC, set the IP address, subnet mask, and default gateway as follows.

  IP address: 172.16.8.13
  Subnet mask: 255.255.255.0
  Default gateway: 172.16.8.12

- Routing settings

  Add routing information to the PC’s routing table to send packets to the sub device.

  From the network settings screen on the PC, add the routing information as follows.

  Network Address for routing: 192.168.1.0
  Netmask for routing: 255.255.255.0
  Gateway Address: 172.16.8.12

  - Example settings for Windows(R) OS

```
> ROUTE ADD 192.168.1.0 MASK 255.255.255.0 172.16.8.12 –p
```

2 Example of main device side setting

- IP address settings

  Set the IP address information for both the network adapter that connects the PC and Ethernet and for the network adapter that connects the sub device and EtherCAT.

  Set the IP address information from the network settings screen of the main device OS.

  Network adapter settings for the Ethernet connection to the PC should be configured as follows.

IP address: 172.16.8.12

Subnet mask: 255.255.255.0

Network adapter settings for connecting the sub device to EtherCAT should be configured as follows.

IP address: 192.168.1.100

Subnet mask: 255.255.255.0

- Routing settings

  This enables Ethernet packets received from the PC to be forwarded to the sub device.

  Enable the IP routing function on the main device.

3 Sub device side setting example

- IP address settings

  On the main device, set the IP address, subnet mask, default gateway, and virtual MAC address of the sub device.

  The EoE function on the sub device side will be enabled once these settings are complete.

  When setting the IP address, set an address in the same subnet as the IP address set in "“2” Example of main device side setting" as shown below.

  Virtual MAC address: 02:01:05:30:03:e9

  IP address: 192.168.1.11

  Subnet mask: 255.255.255.0

  Default gateway: 192.168.1.100

  The IP address shown above is only an example. If connecting multiple sub devices, ensure that there are no duplicate IP addresses.

**— Precautions —**

- Once enabled, the EoE function on the sub device side cannot be disabled by operation from the main device or sub device. The sub device must be restarted in order to disable the EoE function on the sub device side. Therefore, if EoE communication will not be used, do not enable the EoE function on the sub device side.
- If you want to communicate without using the EoE function while the EoE function is still enabled on the sub device side, disable the virtual Ethernet switch function on the main device.

## 12.2 Dimensions

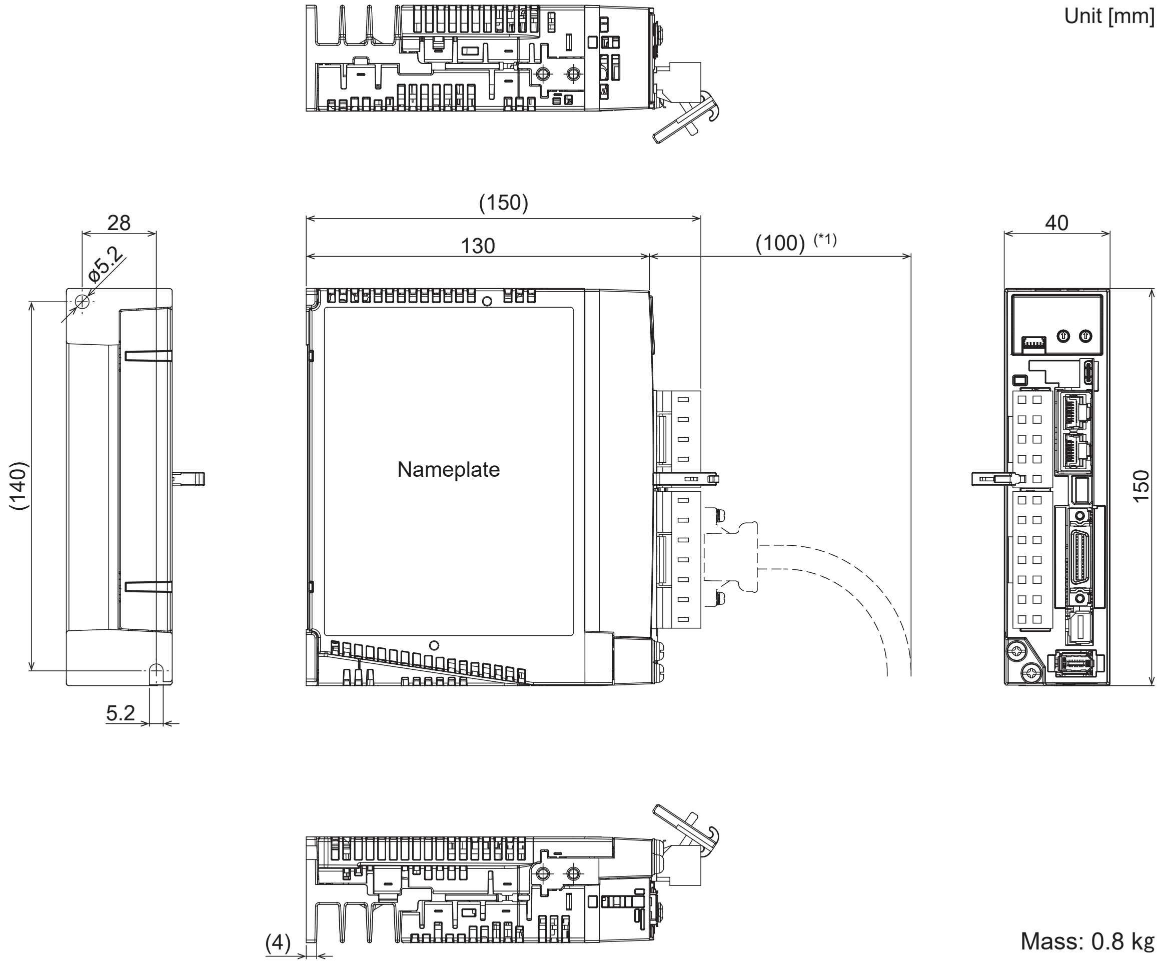
### 12.2.1 Driver

The dimensions are the same for the standard type, multi-function type, and application specialized type for each size. The figure is for the multi-function type.

### 12.2.1.1 Size A (100 V/200 V)

- **Base mount (standard: rear-mount)**

Unit [mm]

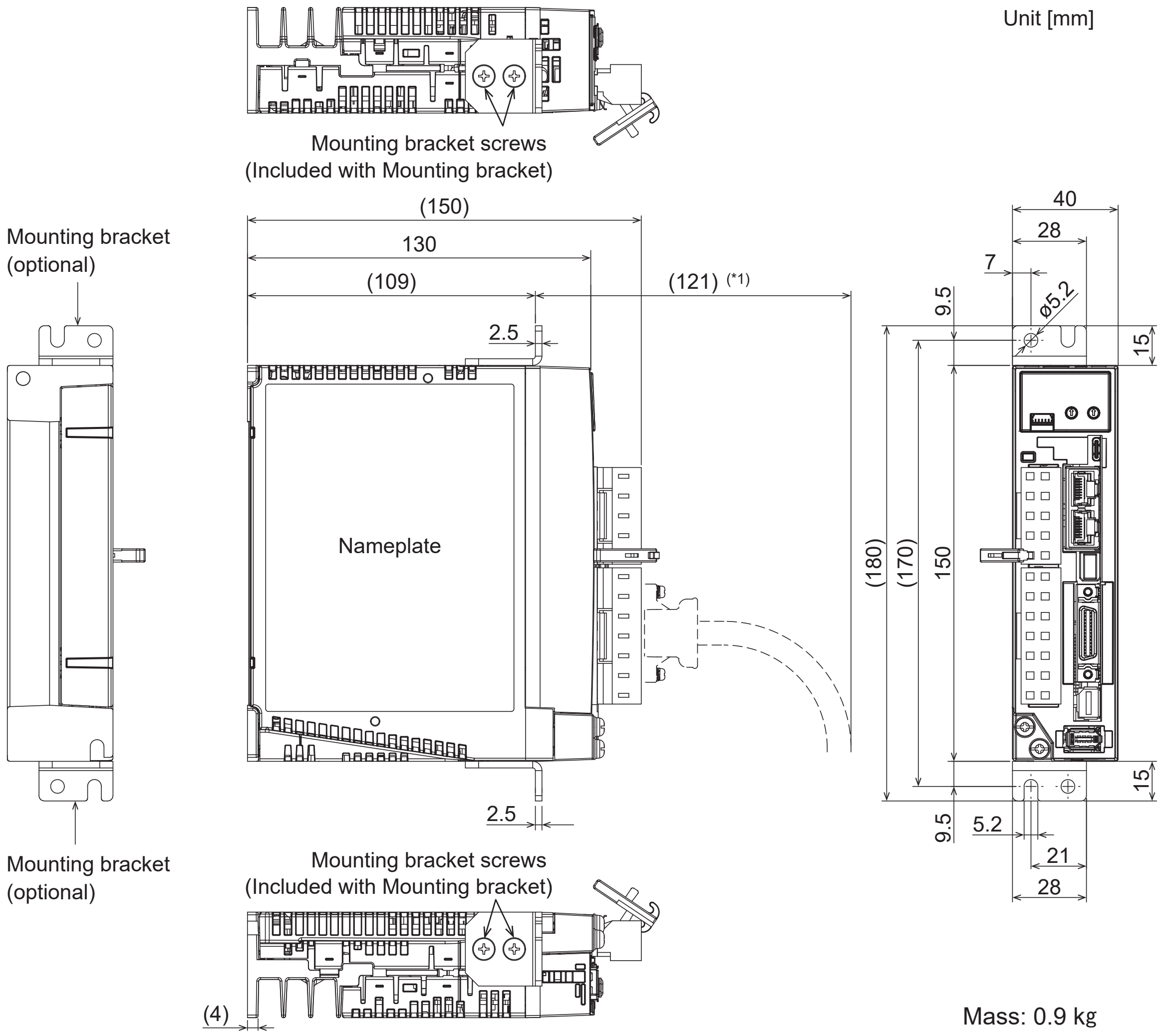


Mass: 0.8 kg

*1 Ensure an appropriate distance for the cables used.

* Do not use screw holes for which no dimensions are shown.

## ■ Rack mount (using optional parts: front-mount)



*1 Ensure an appropriate distance for the cables used.

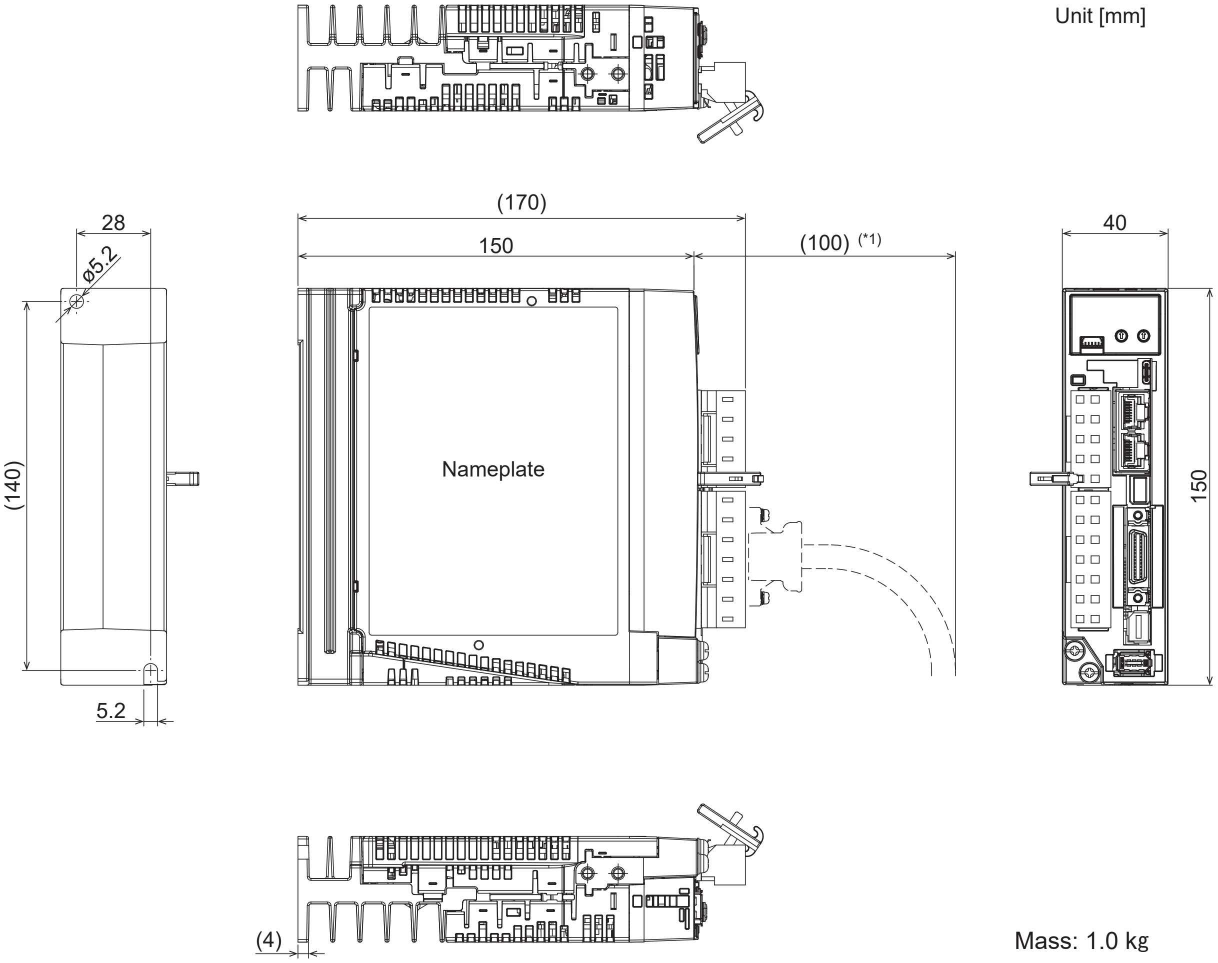
* Do not use screw holes for which no dimensions are shown.

* Mounting brackets are optional parts. They are not included with the product.

### 12.2.1.2 Size B (100 V/200 V)

#### ■ Base mount (standard: rear-mount)

Unit [mm]



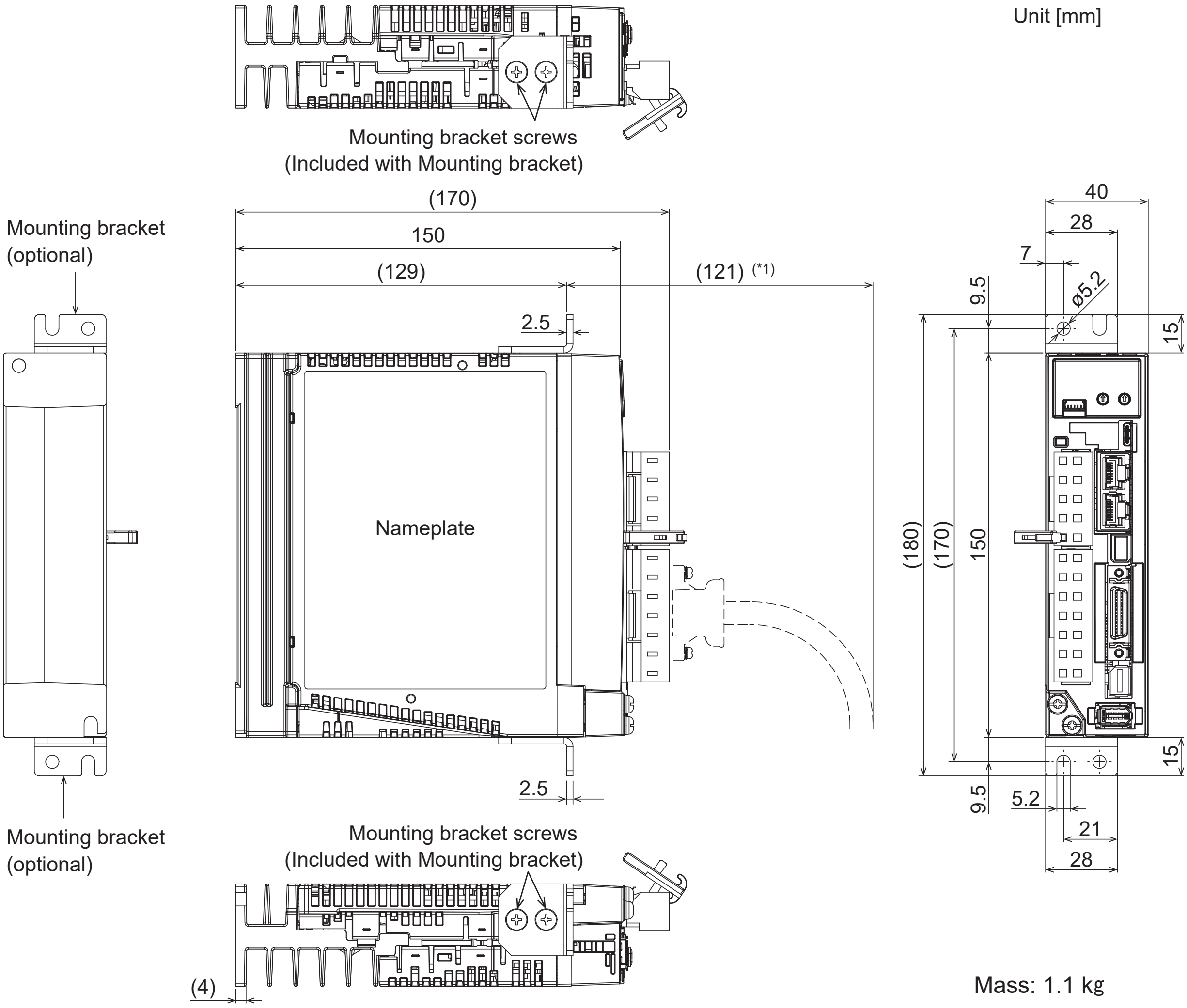
Mass: 1.0 kg

*1 Ensure an appropriate distance for the cables used.

* Do not use screw holes for which no dimensions are shown.

### ■ Rack mount (using optional parts: front-mount)

Unit [mm]



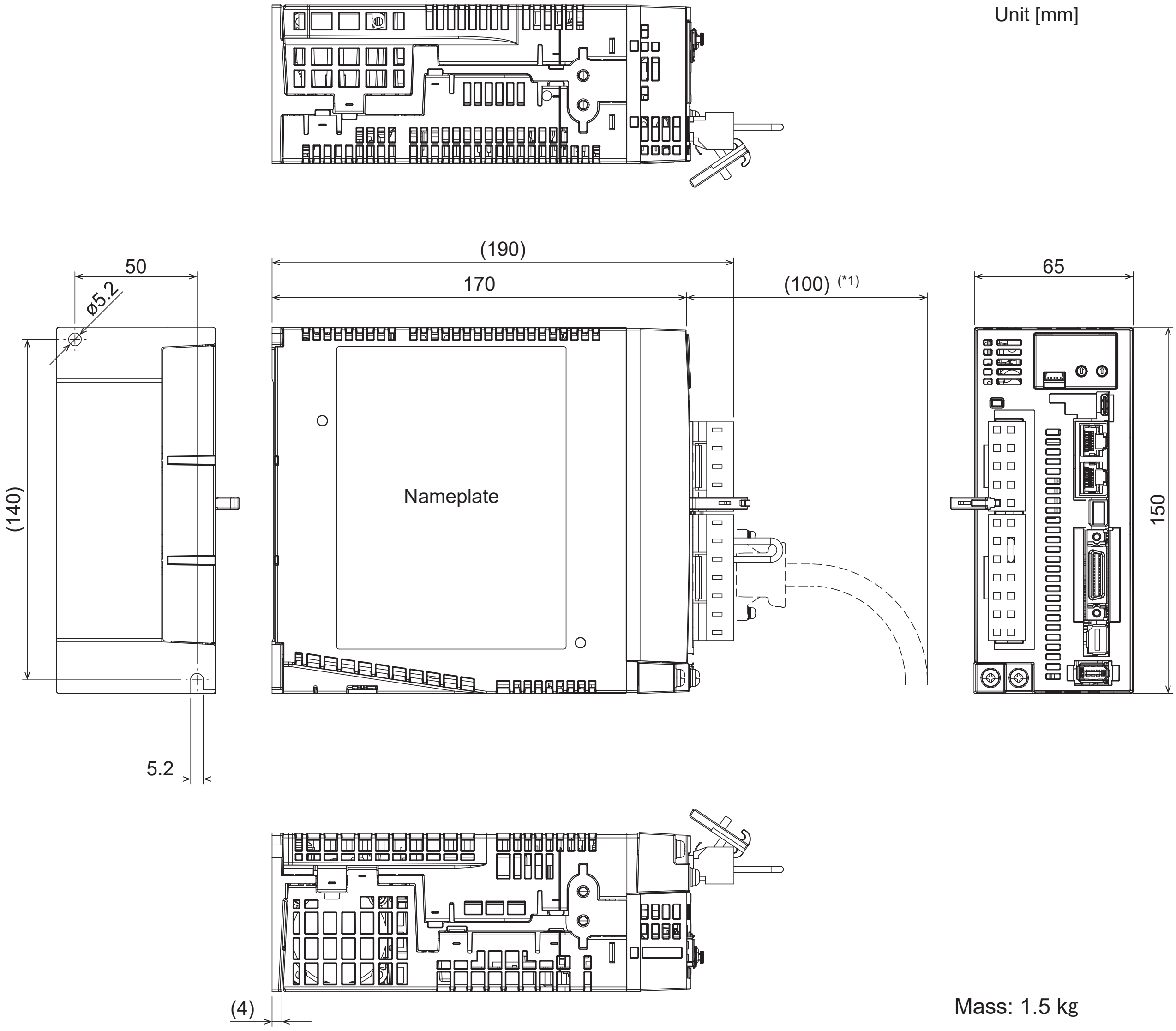
Mass: 1.1 kg

*1 Ensure an appropriate distance for the cables used.

- * Do not use screw holes for which no dimensions are shown.
- * Mounting brackets are optional parts. They are not included with the product.

### 12.2.1.3 Size C (100 V/200 V)

- **Base mount (standard: rear-mount)**



Unit [mm]

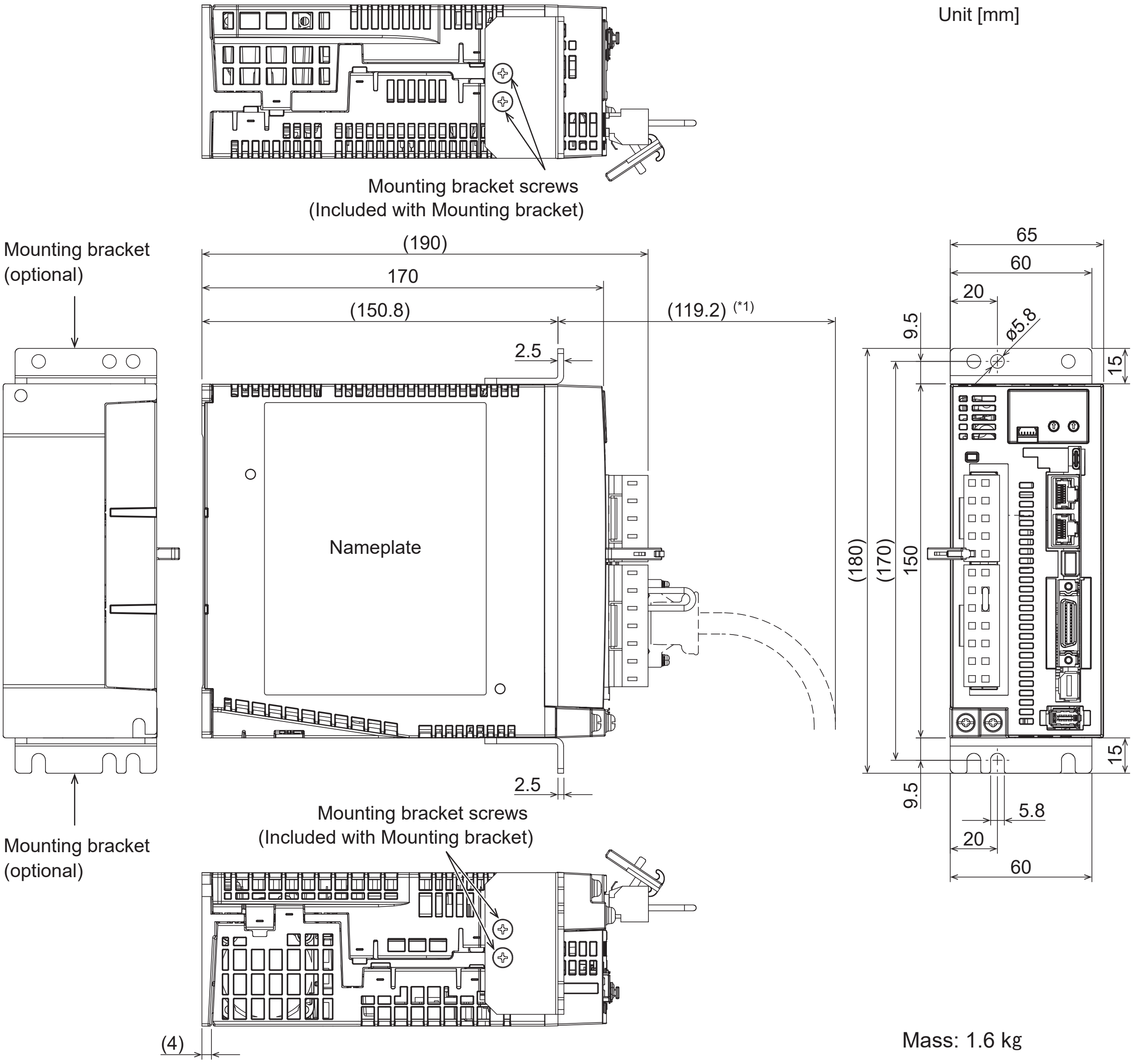
Mass: 1.5 kg

*1 Ensure an appropriate distance for the cables used.

* Do not use screw holes for which no dimensions are shown.

### ■ Rack mount (using optional parts: front-mount)

Unit [mm]



Mass: 1.6 kg

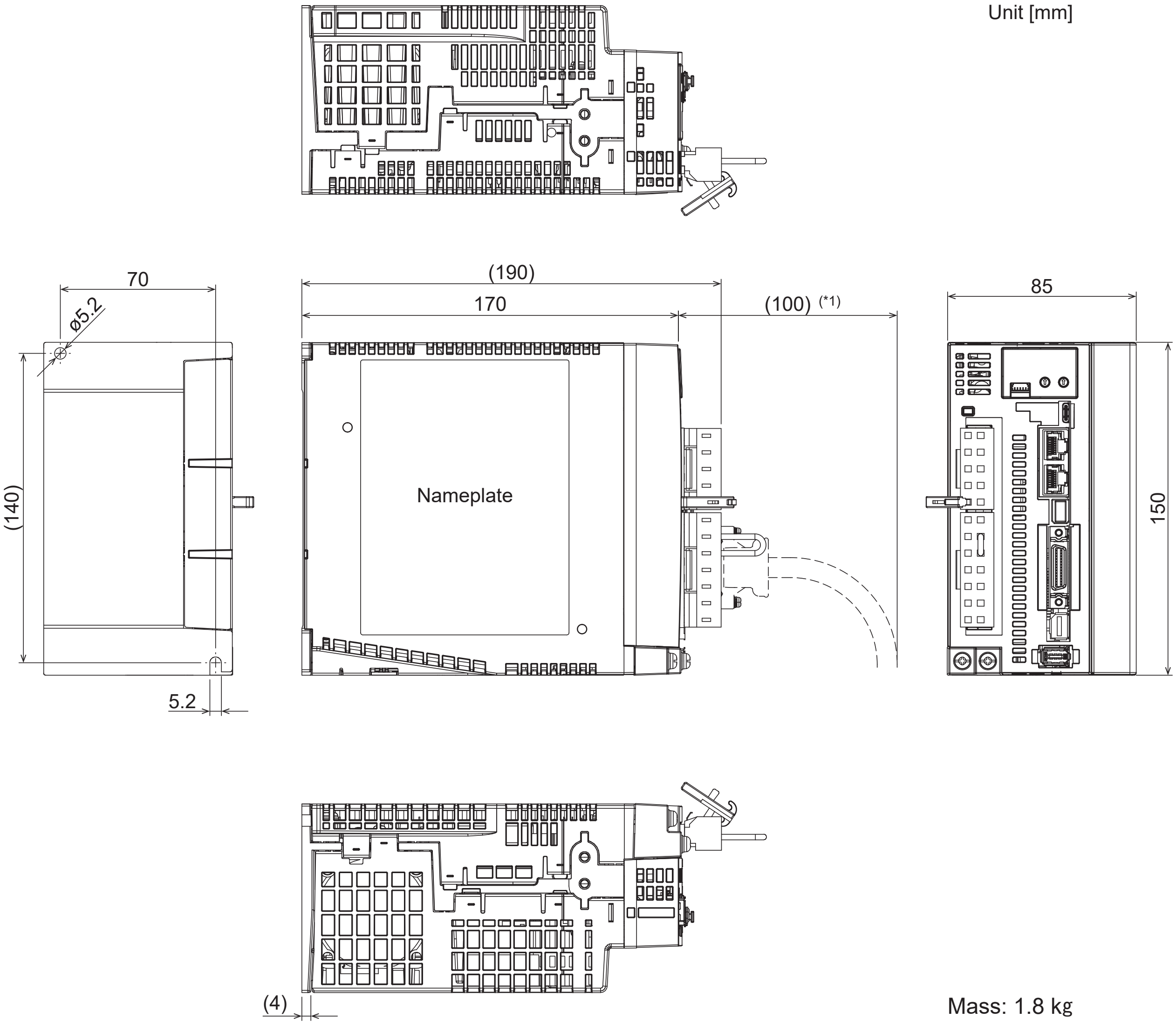
*1 Ensure an appropriate distance for the cables used.

* Do not use screw holes for which no dimensions are shown.

* Mounting brackets are optional parts. They are not included with the product.

### 12.2.1.4 Size D (200 V)

- **Base mount (standard: rear-mount)**

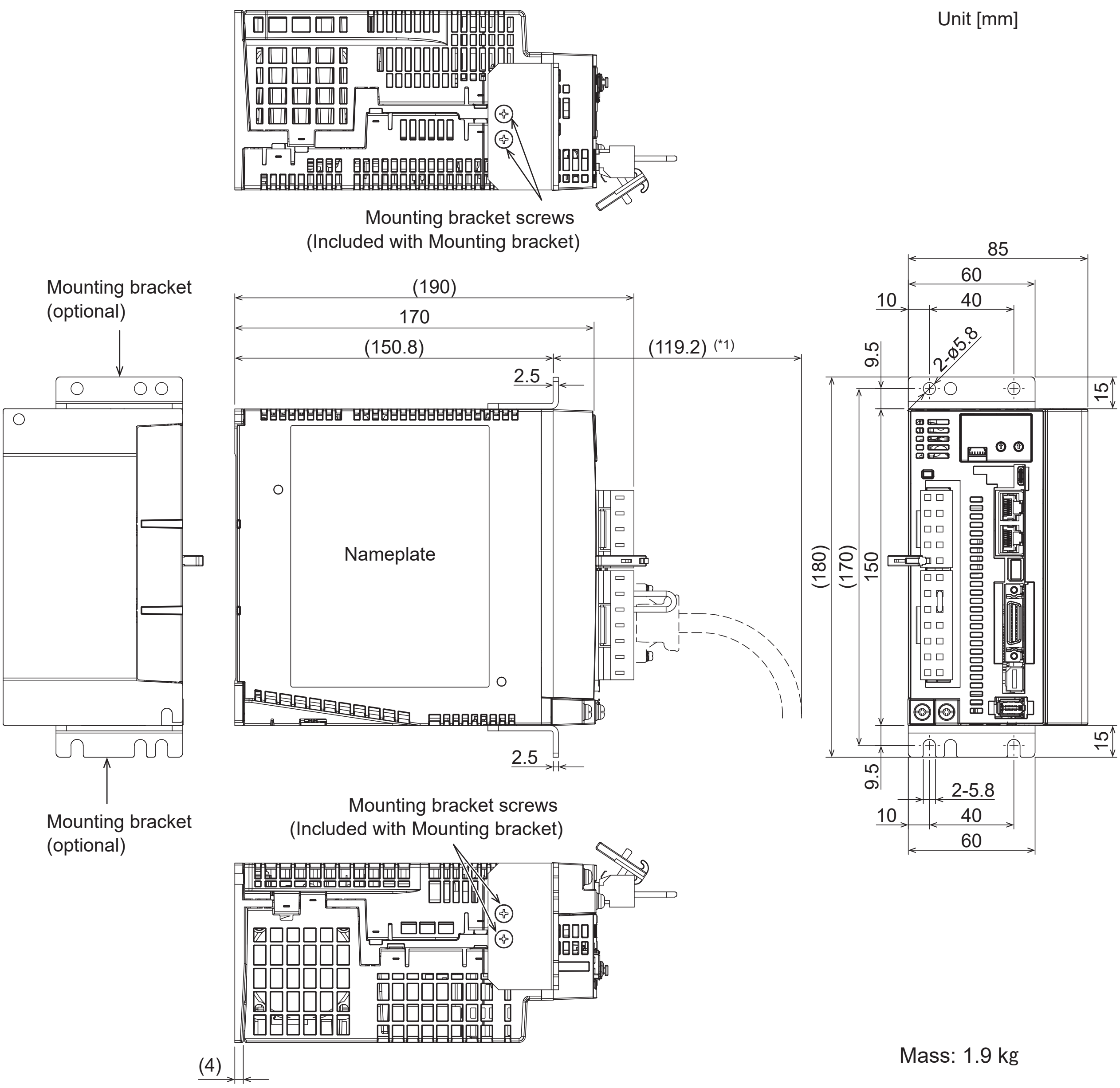


*1 Ensure an appropriate distance for the cables used.

* Do not use screw holes for which no dimensions are shown.

## ■ Rack mount (using optional parts: front-mount)

Unit [mm]



Mass: 1.9 kg

*1 Ensure an appropriate distance for the cables used.

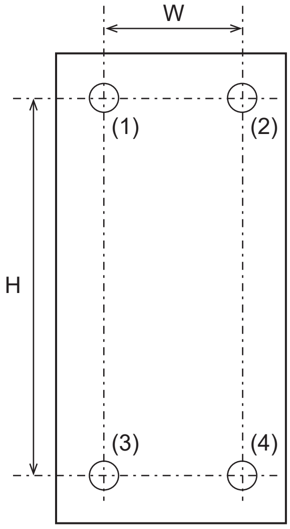
* Do not use screw holes for which no dimensions are shown.

* Mounting brackets are optional parts. They are not included with the product.

#### 12.2.1.5 Mounting Hole Dimensions

Use mounting holes to firmly fix the servo driver to a surface.

**Recommended mounting hole drilling diagram**

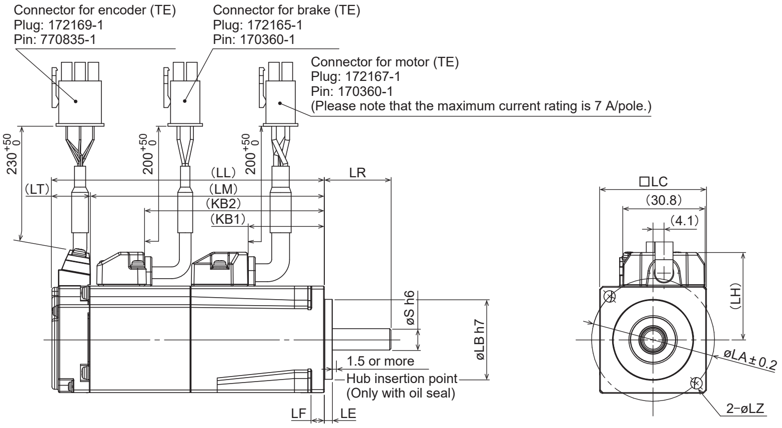


| Size | Mounting hole machining dimensions [mm] | | | | Mounting holes | | Mounting screws (*1) | |
|---|---|---|---|---|---|---|---|---|
| | Base mount | | Rack mount | | Base mount | Rack mount | Nominal | Tightening torque [N·m] |
| | H | W | H | W | | | | |
| A | 140 ± 0.5 | 28 ± 0.5 | 170 ± 0.5 | — | (2), (3) | (1), (3) | M5 | 2.7 to 3.3 |
| B | 140 ± 0.5 | 28 ± 0.5 | 170 ± 0.5 | — | (2), (3) | (1), (3) | M5 | 2.7 to 3.3 |
| C | 140 ± 0.5 | 50 ± 0.5 | 170 ± 0.5 | — | (2), (3) | (1), (3) | M5 | 2.7 to 3.3 |
| D | 140 ± 0.5 | 70 ± 0.5 | 170 ± 0.5 | 40 ± 0.5 | (2), (3) | (1), (2), (3), (4) | M5 | 2.7 to 3.3 |

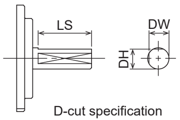
*1 Hexagon socket head cap screws (JIS B 1176:2006) are recommended for use as mounting screws. If the thickness of the mounting plate is 10 mm, use mounting screws with a minimum length of 14 mm.

## 12.2.2 Motor (Absolute Encoder Specification)

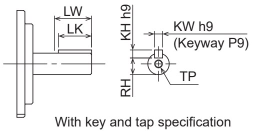
### ■ MHMG 50 W to 100 W



Straight specification
(MHMG□□□U1A2) (MHMG□□□U1B2)
(MHMG□□□U1C2) (MHMG□□□U1D2)



D-cut specification
(MHMG□□□U1N2) (MHMG□□□U1P2)
(MHMG□□□U1Q2) (MHMG□□□U1R2)

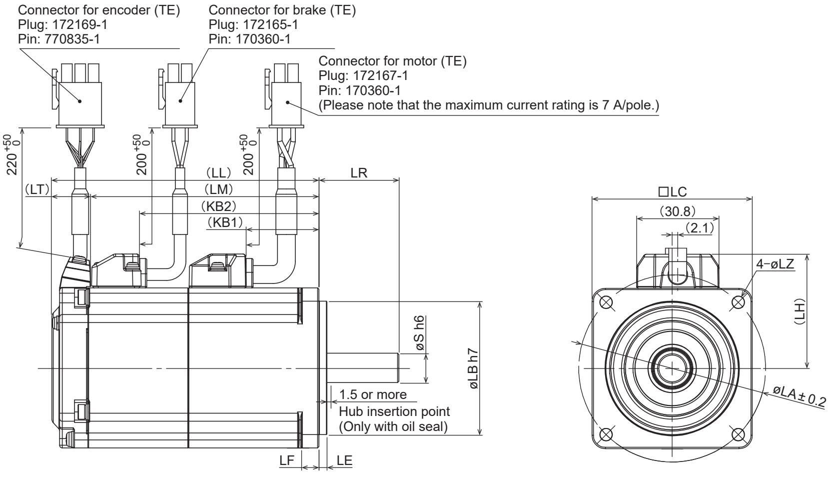


With key and tap specification
(MHMG□□□U1S2) (MHMG□□□U1T2)
(MHMG□□□U1U2) (MHMG□□□U1V2)

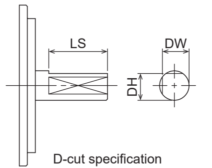
MHMG 50 W to 100 W (High inertia)

| Rated output | | | 50 W | | 100 W | |
|---|---|---|---|---|---|---|
| Motor product number | | | 5AZU1□2 | | 01□U1□2 | |
| Brake | | | No | Yes | No | Yes |
| LL | Without oil seal | mm | 53.8 | 90 | 66 | 102.2 |
| | With oil seal | mm | 53.8 | 90 | 66 | 102.2 |
| LM | | mm | 39.8 | 76 | 52 | 88.2 |
| LT | | mm | 14 | | | |
| KB1 | | mm | 16.3 | 16.3 | 28.5 | 28.5 |
| KB2 | | mm | – | 55.1 | – | 67.3 |
| LR | | mm | 25 | | | |
| S | | mm | 8 | | | |
| LA | | mm | 46 | | | |
| LB | | mm | 30 | | | |
| LC | | mm | 40 | | | |
| LE | | mm | 3 | | | |
| LF | | mm | 5 | | | |
| LH | | mm | 32.7 | | | |
| LZ | | mm | 4.3 | | | |
| Dimensions with key | LW | mm | 14 | | | |
| | LK | mm | 12.5 | | | |
| | KW | mm | 3 | | | |
| | KH | mm | 3 | | | |
| | RH | mm | 6.2 | | | |
| | TP | mm | M3 depth 6 | | | |
| D-cut dimensions | LS | mm | 20 | | | |
| | DW | mm | 7.5 | | | |
| | DH | mm | 7.5 | | | |
| Mass | Without oil seal | kg | 0.29 | 0.51 | 0.37 | 0.60 |
| | With oil seal | | 0.30 | 0.52 | 0.38 | 0.61 |

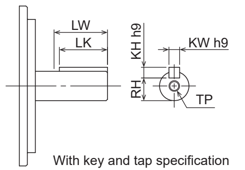
## ■ MHMG 200 W to 400 W



Straight specification
(MHMG□□□U1A2) (MHMG□□□U1B2)
(MHMG□□□U1C2) (MHMG□□□U1D2)



D-cut specification
(MHMG□□□U1N2) (MHMG□□□U1P2)
(MHMG□□□U1Q2) (MHMG□□□U1R2)

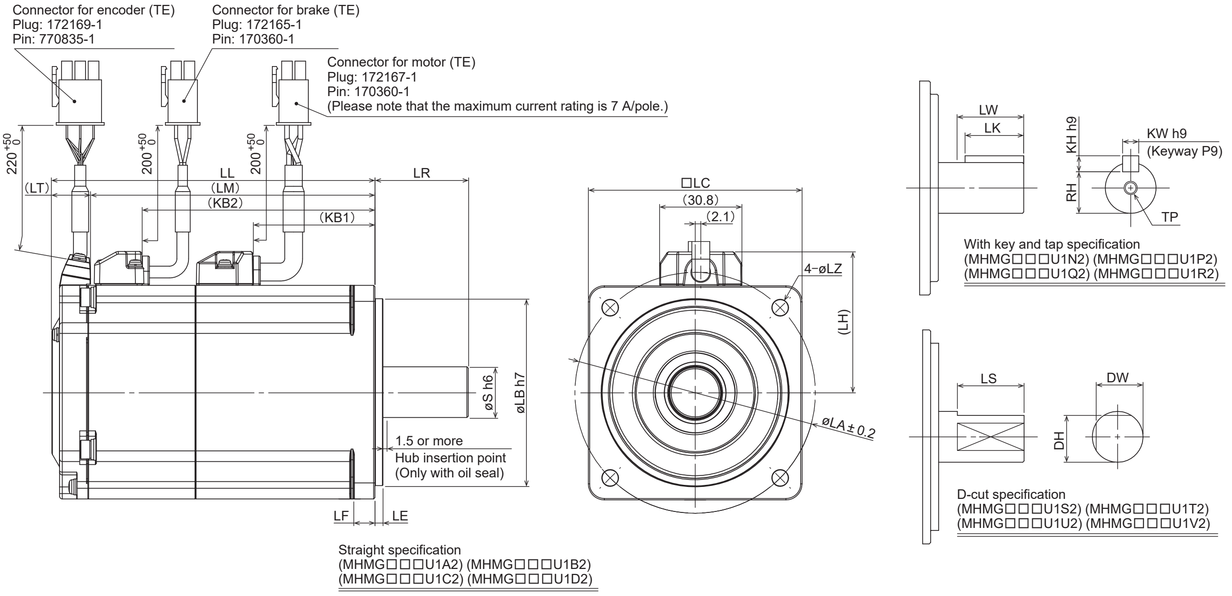


With key and tap specification
(MHMG□□□U1S2) (MHMG□□□U1T2)
(MHMG□□□U1U2) (MHMG□□□U1V2)

MHMG 200 W to 400 W (High inertia)

| Rated output | | | 200 W | | 400 W | |
|---|---|---|---|---|---|---|
| Motor product number | | | 02□U1□2 | | 04□U1□2 | |
| Brake | | | No | Yes | No | Yes |
| LL | Without oil seal | mm | 65.5 | 100.2 | 82 | 116.7 |
| | With oil seal | mm | 65.5 | 100.2 | 82 | 116.7 |
| LM | | mm | 52 | 86.7 | 68.5 | 103.2 |
| LT | | mm | 13.5 | | | |
| KB1 | | mm | 27.3 | 27.3 | 43.8 | 43.8 |
| KB2 | | mm | — | 67.2 | — | 83.7 |
| LR | | mm | 30 | | | |
| S | | mm | 11 | | 14 | |
| LA | | mm | 70 | | | |
| LB | | mm | 50 | | | |
| LC | | mm | 60 | | | |
| LE | | mm | 3 | | | |
| LF | | mm | 6.5 | | | |
| LH | | mm | 42.7 | | | |
| LZ | | mm | 4.5 | | | |
| Dimensions with key | LW | mm | 20 | | 25 | |
| | LK | mm | 18 | | 22.5 | |
| | KW | mm | 4 | | 5 | |
| | KH | mm | 4 | | 5 | |
| | RH | mm | 8.5 | | 11 | |
| | TP | mm | M4 depth 8 | | M5 depth 10 | |
| D-cut dimensions | LS | mm | 22 | | | |
| | DW | mm | 10 | | 12.5 | |
| | DH | mm | 10 | | 12.5 | |
| Mass | Without oil seal | kg | 0.73 | 1.2 | 1.0 | 1.5 |
| | With oil seal | | 0.74 | 1.2 | 1.0 | 1.5 |

## ■ MHMG 750 W to 1000 W

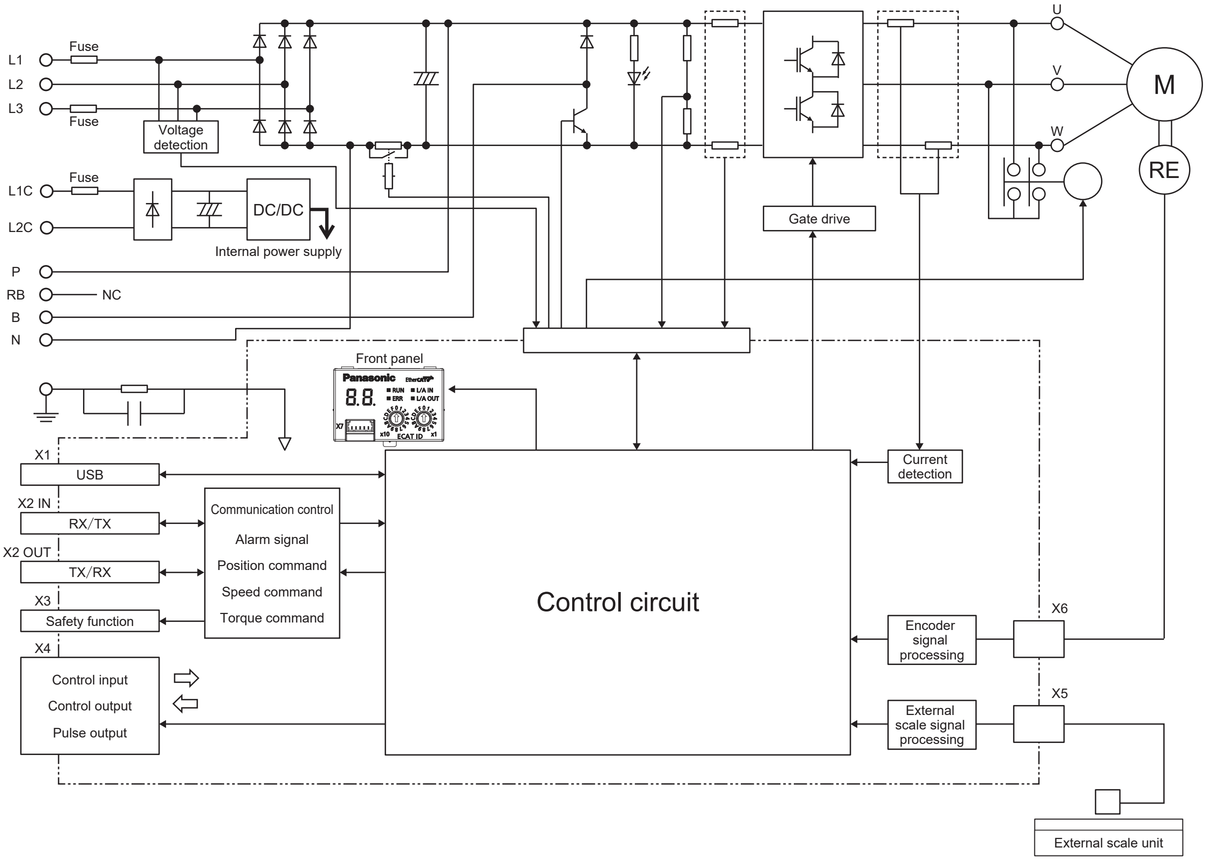


MHMG 750 W to 1000 W (High inertia)

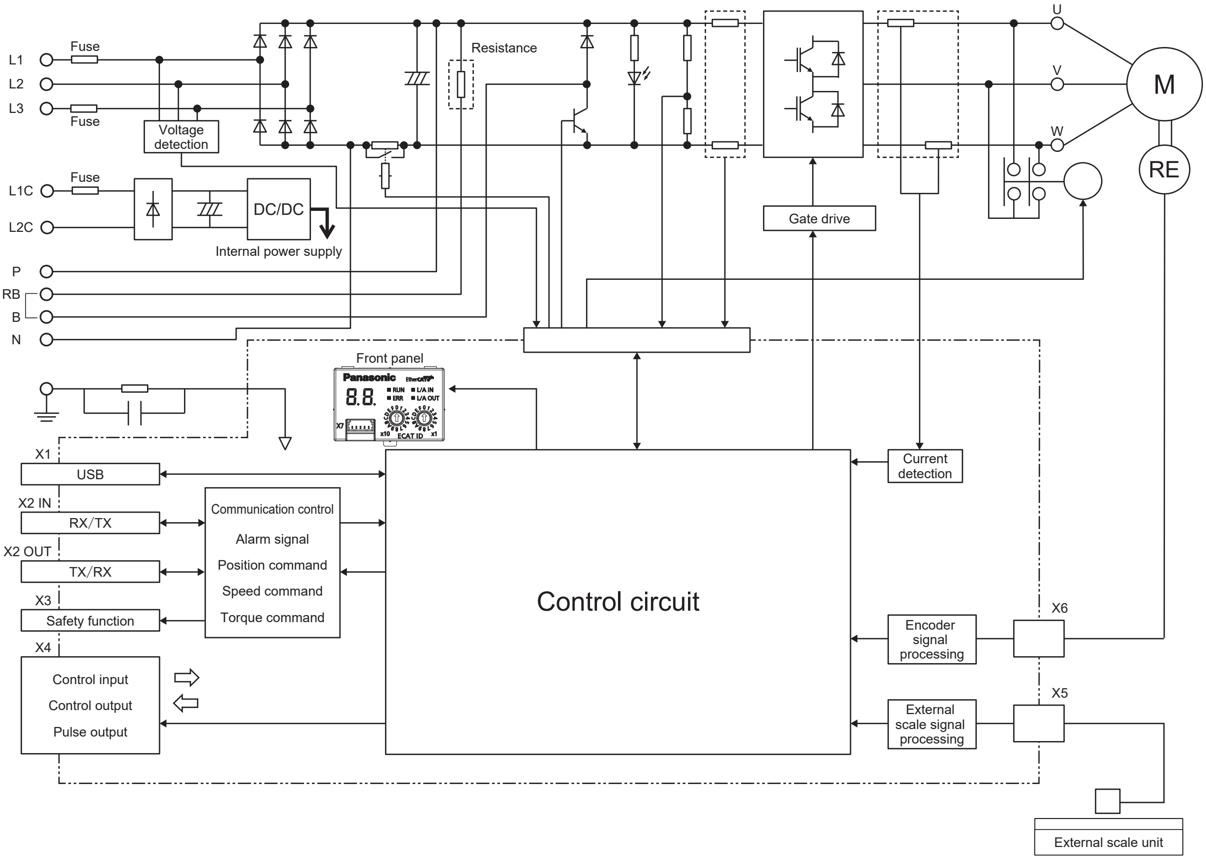
| Rated output | | | 750 W | | 1000 W | |
|---|---|---|---|---|---|---|
| Motor product number | | | 082U1☐2 | | 092U1☐2 | |
| Brake | | | No | Yes | No | Yes |
| LL | Without oil seal | mm | 86 | 121.2 | 97.2 | 132.4 |
| | With oil seal | mm | 86 | 121.2 | 97.2 | 132.4 |
| LM | | mm | 72.5 | 107.7 | 83.7 | 118.9 |
| LT | | mm | 13.5 | | | |
| KB1 | | mm | 45.6 | 45.6 | 56.8 | 56.8 |
| KB2 | | mm | — | 87.2 | — | 98.4 |
| LR | | mm | 35 | | | |
| S | | mm | 19 | | | |
| LA | | mm | 90 | | | |
| LB | | mm | 70 | | | |
| LC | | mm | 80 | | | |
| LE | | mm | 3 | | | |
| LF | | mm | 8 | | | |
| LH | | mm | 52.7 | | | |
| LZ | | mm | 6 | | | |
| Dimensions with key | LW | mm | 25 | | | |
| | LK | mm | 22 | | | |
| | KW | mm | 6 | | | |
| | KH | mm | 6 | | | |
| | RH | mm | 15.5 | | | |
| | TP | mm | M5 depth 10 | | | |
| D-cut dimensions | LS | mm | 25 | | | |
| | DW | mm | 17.5 | | | |
| | DH | mm | 17.5 | | | |
| Mass | Without oil seal | kg | 1.9 | 2.7 | 2.3 | 3.1 |
| | With oil seal | | 1.9 | 2.7 | 2.3 | 3.1 |

## 12.3 Servo Driver Block Diagram

### ■ Sizes A, B (100 V/200 V)



### ■ Size C (100 V/200 V), Size D (200 V)



# 12.4 Optional Parts

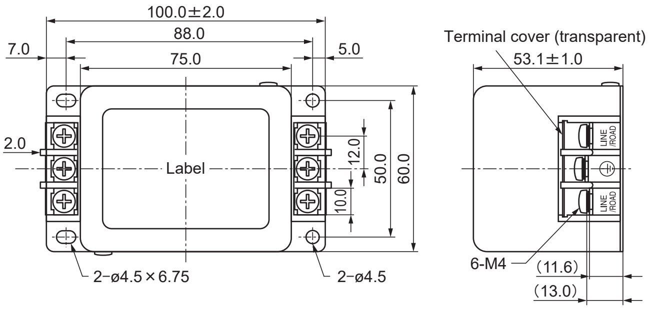
## 12.4.1 Noise Filter

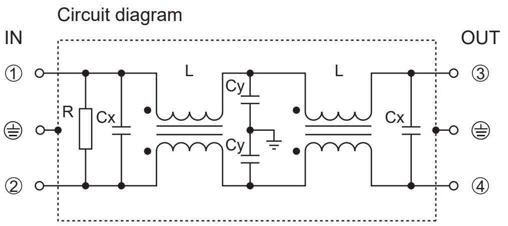
If using multiple servo drivers and installing one noise filter for all the power supply parts collectively, consult the manufacturer of the noise filter. If a noise margin is required, connect 2 filters in series to emphasize effectiveness.

### ■ Optional parts

| Driver part no. | Driver voltage specifications | Noise filter | | |
|---|---|---|---|---|
| | | Optional product number | Manufacturer product number | Manufacturer |
| MADN061□□ | Single phase 100 V | DV0PM4170 | SUP-EK5-ER-6 | Okaya Electric Industries |
| MADN081□□ | | | | |
| MBDN121□□ | | | | |
| MCDN201□□ | | DV0PM20042 | 3SUP-HU10-ER-6 | |
| MADN065□□ | Single phase/3-phase 200 V | DV0PM4170 (for single phase)<br>or<br>DV0PM20042 (for 3-phase) | SUP-EK5-ER-6 (for single phase)<br>or<br>3SUP-HU10-ER-6 (for 3-phase) | |
| MADN085□□ | | | | |
| MBDN125□□ | | | | |
| MCDN205□□ | | DV0PM20042 | 3SUP-HU10-ER-6 | |
| MDDN405□□ | | DV0P4220 | 3SUP-HU30-ER-6 | |

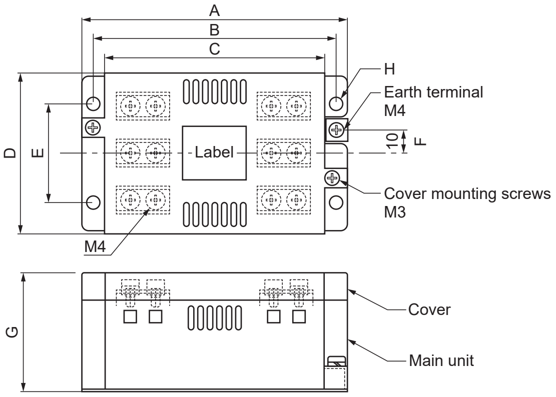
**DV0PM4170**

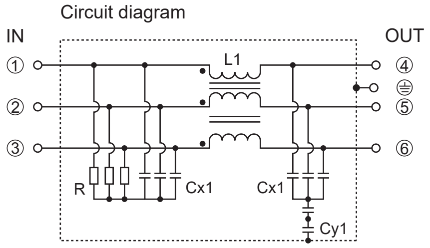




[Unit: mm]

**DV0PM20042, DV0P4220**





* Dimensions [Unit: mm]

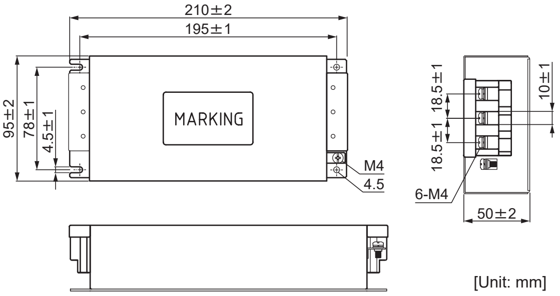
| Optional product number | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| DV0PM20042 | 115 | 105 | 95 | 70 | 43 | 10 | 52 | 5.5 |
| DV0P4220 | 145 | 135 | 125 | 70 | 50 | 10 | 52 | 5.5 |

For single phase, use two of the three terminals. Do not connect anything to the remaining terminal.

## ■ Other recommended parts

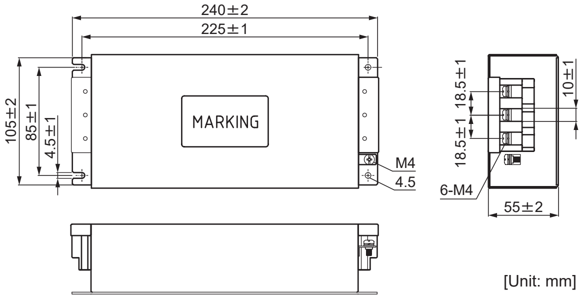
| Applicable (servo driver size) | Driver voltage specifications | Noise filter | | |
|---|---|---|---|---|
| | | Manufacturer product number | Rated current | Manufacturer |
| MADN061□□ | Single phase 100 V | RTHN-5010 | 10 A | TDK-Lambda Corporation |
| MADN081□□ | | | | |
| MBDN121□□ | | | | |
| MCDN201□□ | | | | |
| MADN065□□ | Single phase/3-phase 200 V | | | |
| MADN085□□ | | | | |
| MBDN125□□ | | | | |
| MCDN205□□ | | | | |
| MDDN405□□ | | RTHN-5030 | 30 A | |

**RTHN-5010**



[Unit: mm]

**RTHN-5030**



[Unit: mm]

**— Precautions —**

- Select a noise filter with a capacity that matches the power supply capacity (considering load conditions).
- For the detailed specifications of each noise filter, contact the manufacturer.
- Use options properly, reading their respective operating instructions and sufficiently checking precautions before use. Please avoid placing excessive stress on products and cables.

## 12.4.2 Surge Absorber

Install the surge absorber on the primary side of the noise filter.

### ■ Compatible parts

| Driver voltage specifications | Manufacturer Product Number | Manufacturer |
|---|---|---|
| 3-phase 200 V | RSPD-250-U4 | Okaya Electric Industries |
| Single-phase<br>100 V, 200 V | RSPD-250-Q4 | |

**— Precautions —**

- Always remove the surge absorber before high voltage insulation testing machinery and equipment. Failure to do so may result in damage to the surge absorber.

## 12.4.3 Ferrite Core

Ensure all cables (motor cables, encoder cables, interface cables, USB cables) have a ferrite core.

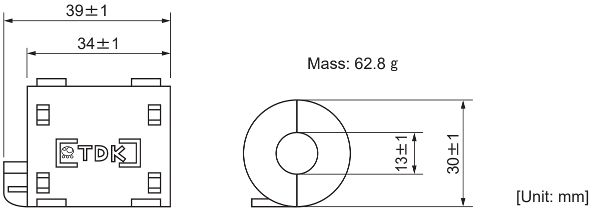
### ■ Optional parts

Encoder cable, interface cable, and USB cables

| Optional Product Number | Manufacturer Product Number | Manufacturer |
|---|---|---|
| DV0P1460 | ZCAT3035-1330 | TDK Corporation |

* The quantity at the time of purchase is 4.

**DV0P1460**



**— Precautions —**

- Fix the ferrite core to prevent excessive stress on cables.
- Adjust the length of the jacket as needed when installing the connector XB cable.

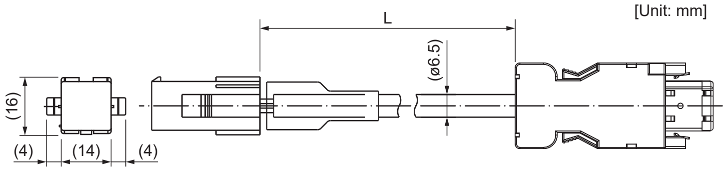
## 12.4.4 Relay Cable for Encoder

| Product name | Optional product number | Compatible motor outputs | Remarks |
|---|---|---|---|
| Relay cable for absolute encoder | MFECA0**0EAD (*1) | MHMG 50 W and 1000 W (□80) (Lead wire type) | No battery box |

*1 The ** in product numbers indicates the “L” dimension in the dimensions shown below.

| ** section | L (m) |
|---|---|
| 03 | 3 |
| 05 | 5 |
| 10 | 10 |

**MFECA0**0EAD**



Components

| Name | Manufacturer product number | Manufacturer |
|---|---|---|
| Connector (driver side) | 3E206-0100KV | 3M Japan or equivalent product |
| Shell kit | 3E306-3200-008 | |
| Connector (motor side) | 172161-1 | Tyco Electronics Japan G.K. |
| Connector pin | 170365-1 | |
| Cable | 0.20 $mm^2$ × 3P (6-core) | Oki Electric Cable Co., Ltd. |

**— Precautions —**

- Optional cables not compatible with IP65 or IP67.

## 12.4.5 Motor Relay Cable

Refer to *“1.8.2.3.2 Wire Specifications by Model”* when selecting wire sizes in order to comply with international standards.

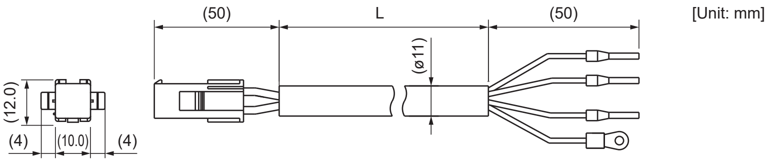
Check with the manufacturer for the pin product numbers of the appropriate connectors.

| Product name | Optional product number | Compatible motor outputs |
|---|---|---|
| Relay cable for motor (no brake) | MFMCA0**OEED (*1) | MHMG 50 W and 1000 W (□ 80)<br>(Lead wire type) |

*1 The ** in product numbers indicates the “L” dimension in the dimensions shown below.

| ** section | L (m) |
|---|---|
| 03 | 3 |
| 05 | 5 |
| 10 | 10 |
| 20 | 20 |

**MFMCA0**OEED**



Components

| Name | Manufacturer product number | Manufacturer |
|---|---|---|
| Connector | 172159-1 | Tyco Electronics Japan G.K. |
| Connector pin | 170366-1 | |
| Terminal | AI0.75+8GY | Phoenix Contact |
| Nylon-insulated ring tongue terminal | N1.25-M4 | J.S.T. Mfg. Co., Ltd. |
| Cable | ROBO-TOP 600 V<br>AWG18 (0.75 mm$^2$) 4-core | Dyden Corporation |

**— Precautions —**

- Optional cables not compatible with IP65 or IP67.

## 12.4.6 Relay Cable for Brake

Refer to *“1.8.2.3.2 Wire Specifications by Model”* when selecting wire sizes in order to comply with international standards.

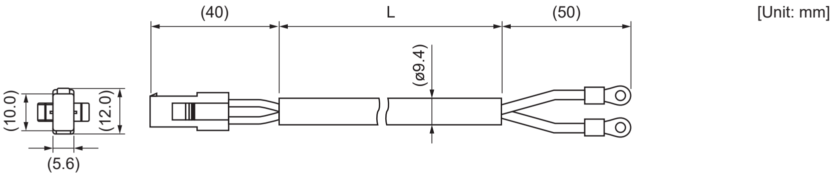
Check with the manufacturer for the pin product numbers of the appropriate connectors.

| Product name | Optional product number | Compatible motor outputs |
|---|---|---|
| Relay cable for brake | MFMCB0**0GET (*1) | MHMG 50 W and 1000 W (□80)<br>(Lead wire type) |

*1 The ** in product numbers indicates the “L” dimension in the dimensions shown below.

| ** section | L (m) |
|---|---|
| 03 | 3 |
| 05 | 5 |
| 10 | 10 |
| 20 | 20 |

**MFMCB0**0GET**



Components

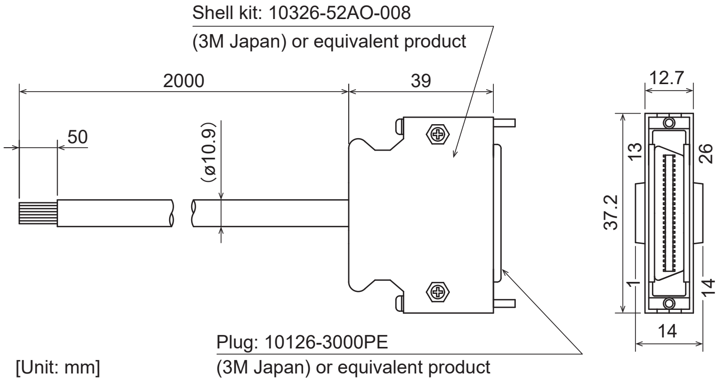
| Name | Manufacturer product number | Manufacturer |
|---|---|---|
| Connector | 172157-1 | Tyco Electronics Japan G.K. |
| Connector pin | 170366-1, 170362-1 | |
| Nylon-insulated ring tongue terminal | N1.25-M4 | J.S.T. Mfg. Co., Ltd. |
| Cable | ROBO-TOP 600 V<br>AWG18 (0.75 $mm^2$) 2-core | Dyden Corporation |

**— Precautions —**

- Optional cables not compatible with IP65 or IP67.

## 12.4.7 Interface Cable

| Product name | Option product number |
|---|---|
| Interface cable | DV0PM24679 |



An AWG26 core wire with 2 m of electric wire is connected.

Wiring table

| Pin No. | Signal name | Core wire color |
|---|---|---|
| 1* | BRK-OFF+ | Orange (Red 1) |
| 2* | BRK-OFF- | Orange (Black 1) |
| 3* | ALM+ | Gray (Red 1) |
| 4* | ALM- | Gray (Black 1) |
| 5* | SI-MON5 | White (Red 1) |
| 6 | SI-COM | White (Black 1) |
| 7* | POT | Yellow (Red 1) |
| 8* | NOT | Yellow (Black 1) |
| 9* | HOME | Pink (Red 1) |

| Pin No. | Signal name | Core wire color |
|---|---|---|
| 10* | EXT1 | Pink (Black 1) |
| 11* | EXT2 | Orange (Red 2) |
| 12* | SI-MON3 | Orange (Black 2) |
| 13* | SI-MON4 | Gray (Red 2) |
| 14 | BTP-I | Gray (Black 2) |
| 15 | BTN-I | White (Red 2) |
| 16 | GND | White (Black 2) |
| 17 | OA+/OCMP1+ | Yellow (Red 2) |
| 18 | OA-/OCMP1- | Yellow (Black 2) |

| Pin No. | Signal name | Core wire color |
|---|---|---|
| 19 | OB-/OCMP2- | Pink (Red 2) |
| 20 | OB+/OCMP2+ | Pink (Black 2) |
| 21 | OCMP3+ | Yellow (Red 3) |
| 22 | OCMP3- | Yellow (Black 3) |
| 23 | AIN (NC) | Pink (Red 3) |
| 24 | GND (NC) | Pink (Black 3) |
| 25* | EX-OUT1+ | Orange (Red 4) |
| 26* | EX-OUT1- | Orange (Black 4) |

* Signal assignments for pin No. marked with an asterisk (*) in the table are the initial values.

* For details on signal assignment, see *"3.2.5 Wiring to Connector X4 (Connecting to I/O)"* .

**Notes**

- The lead wires of the core cables are marked with colors and dots. Using for pin No. 1 as an example, orange in the wiring table indicates the color of the lead wire of the core cable, while (red 1) indicates a single red dot mark.

  The shield of the interface cable connects to the connector shell but not to the terminals.
- In the above table, the 23-pin analog input (AIN) and 24-pin ground connection (GND) can only be used for the application specialized type. Do not use for connecting the standard type or multi-function type (NC).

## 12.4.8 Connector Kits

### 12.4.8.1 Connector Kit for Interface

| Product name | Optional product number |
|---|---|
| Connector kit for interface | DV0P0770 |

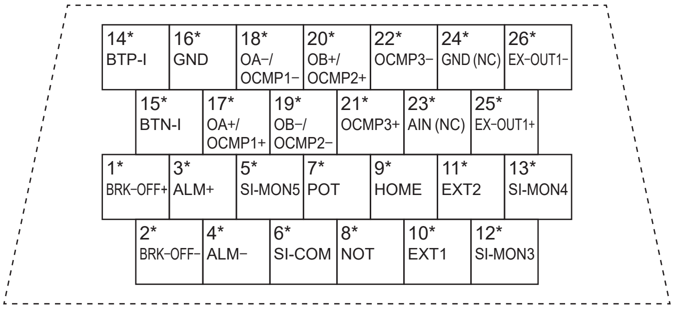
Components

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector | 10126-3000PE | 3M Japan | For X4 connector (26-pin) |
| Connector cover | 10326-52A0-008 | | |

Other recommended parts

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector | DF02P026F22A1 | Japan Aviation Electronics Industry, Ltd. | For X4 connector (26-pin) |
| Connector cover | DF02D026B22 | | |

**Pin arrangement for connector (26-pin) (as seen from the cable side)**



* Signal assignments for pin No. marked with an asterisk (*) in the figure are the initial values.

* For details on signal assignment, see *“3.2.5 Wiring to Connector X4 (Connecting to I/O)”* .

**— Precautions —**

- When wiring, also check the pin numbers marked on the connector body.
- In the above figure, the 23-pin analog input (AIN) and 24-pin ground connection (GND) can only be used for the application specialized type. Do not use for connecting the standard type or multi-function type (NC).

**Notes**

- Check the required crimping tools for cable production on the manufacturer’s website, or with the manufacturer directly. For manufacturer contact information, see *“12.4.14 List of Peripheral Device Manufacturers”* .

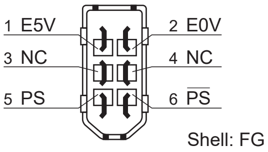
### 12.4.8.2 Connector Kit for Encoder

| Product name | Optional product number |
|---|---|
| Connector kit for encoder | DV0PM20010 |

Components

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector (driver side) | 3E206-0100KV | 3M Japan | For X6 connector |
| Shell kit | 3E306-3200-008 | 3M Japan | |

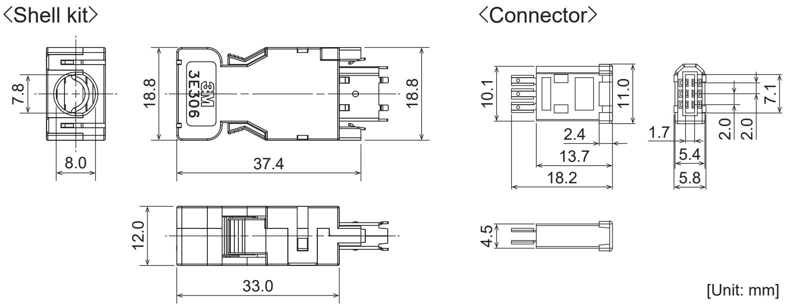
**Pin arrangement for X6 connector**



(View from the cable side)

<<Caution>>
Do not connect anything to the pin labeled “NC”.

**Dimensions diagram**



Other recommended parts

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector (driver side)<br>*With shell kit | 2271871-1 | Tyco Electronics Japan G.K. | For X6 connector |

### 12.4.8.3 Connector Kit for Power Supply Input

| Product name | Optional product number | Remarks |
|---|---|---|
| Connector kit for power supply input | DV0PM24685 | For sizes A to D: 1-row type |

Components

| Name | Manufacturer product number | No. of pcs. | Manufacturer | Remarks |
|---|---|---|---|---|
| Connector | 05JFAT-SAXGSAK-KM7.5 (LA) | 1 | J.S.T. Mfg. Co., Ltd. | For XA connector |
| Control lever | J-FAT-OT-EXL | 1 | | |

### 12.4.8.4 Connector Kit for Motor

| Product name | Optional product number |
|---|---|
| Connector kit for motor | DV0PM24687 |

Components

| Name | Manufacturer product number | No. of pcs. | Manufacturer | Remarks |
|---|---|---|---|---|
| Connector | 07JFAT-SAXGSAK-KM7.5 (LA) | 1 | J.S.T. Mfg. Co., Ltd. | For XB connector |
| Control lever | J-FAT-OT-EXL | 1 | | |

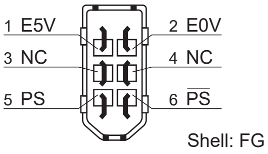
### 12.4.8.5 Connector Kit for Motor Encoder

| Product name | Optional product number | Compatible motor outputs | Remarks |
|---|---|---|---|
| Connector kit for motor encoder | DV0P4290 | MHMG 50 W and 1000 W (□80) | Without brake |

Components

| Name | Manufacturer product number | No. of pcs. | Manufacturer | Remarks |
|---|---|---|---|---|
| Connector (driver side) | 3E206-0100KV | 1 | 3M Japan<br>or equivalent product | For X6 connector (6-pin) |
| Shell kit | 3E306-3200-008 | 1 | | |
| Connector | 172161-1 | 1 | Tyco Electronics Japan G.K. | For encoder cable (9-pin) |
| Connector pin | 170365-1 | 9 | | |
| Connector | 172159-1 | 1 | | For motor cable (4-pin) |
| Connector pin | 17036601 | 4 | | |

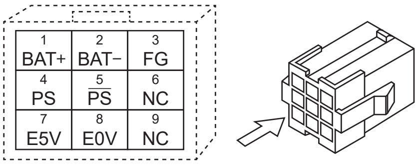
**Pin arrangement for X6 connector**



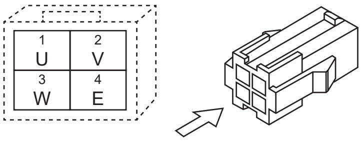
(View from the cable side)

<<Caution>>
Do not connect anything to the pin labeled “NC”.

**Pin arrangement for encoder cable connector**



**Pin arrangement for motor cable connector**



**— Precautions —**

- The customer must carry out appropriate processing when IP65 or IP67 is required.
- Check the required crimping tools for cable production on the manufacturer’s website, or with the manufacturer directly. For manufacturer contact information, see *“12.4.14 List of Peripheral Device Manufacturers”* .

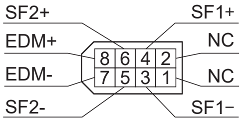
Other recommended parts

| Name | Manufacturer product number | No. of pcs. | Manufacturer | Remarks |
|---|---|---|---|---|
| Connector (driver side)<br>*With shell kit | 2271871-1 | 1 | Tyco Electronics Japan G.K. | For X6 connector (6-pin) |

### 12.4.8.6 Connector Kit for Safety

| Product name | Optional product number |
|---|---|
| Connector kit for safety | DV0PM20103 |

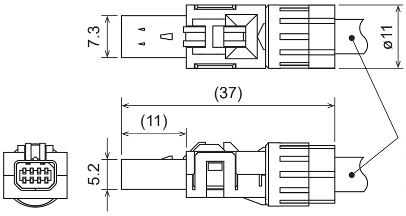
#### Pin arrangement for X3 connector



Shell: FG
(View from the cable side)

<<Caution>>
Do not connect anything to the pin labeled “NC”.

#### Dimensions diagram



[Unit: mm]

Recommended wire diameter: ø6 mm
Recommended core wire diameter: AWG26 to AWG30

Note: Electric wires are not included.

Components

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector | CIF-PCNS08KK-071R | J.S.T. Mfg. Co., Ltd. | For X3 connector (8-pin) |

**Notes**

- Cannot be used for the standard type.

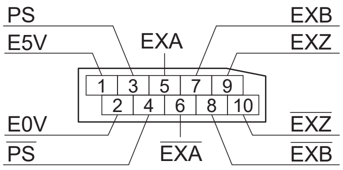
Other recommended parts

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector | 2013595-1 | Tyco Electronics Japan G.K. | For X3 connector (8-pin) |
| | 2201855-1 | | For X3 connector (8-pin)<br>Piercing type |

### 12.4.8.7 Connector Kit for External Scale

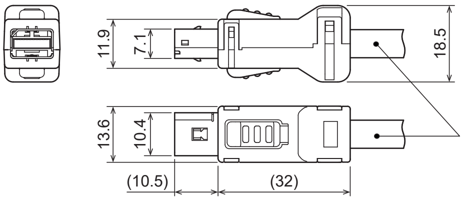
| Product name | Optional product number |
|---|---|
| Connector kit for external scale | DV0PM20026 |

**Pin arrangement for X5 connector**



(View from the cable side)

**Dimensions diagram**



[Unit: mm]

Recommended wire diameter: ø6 mm
Recommended core wire diameter: AWG26 to AWG30
Note: Electric wires are not included.

Components

| Name | Manufacturer product number | Manufacturer | Remarks |
|---|---|---|---|
| Connector | MUF-PK10K-X | J.S.T. Mfg. Co., Ltd. | For X5 connector (10-pin) |

**Notes**

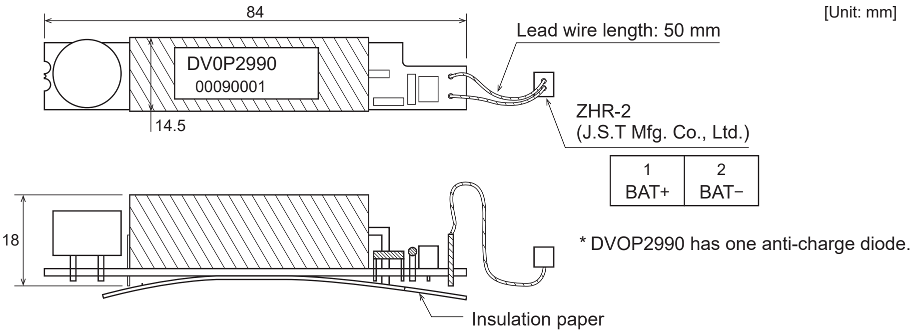
- Cannot be used for the standard type.

## 12.4.9 Battery for Absolute Encoder

### ■ Battery

| Product name | Optional product number |
|---|---|
| Battery | DV0P2990 |

**Lithium battery: 3.6 V 2000 mAh**



**— Precautions —**

- Applications for shipment as a hazardous material may be required for air shipments (both passenger and cargo aircraft).

  Consult with the shipping company (airline) when requesting air shipments.

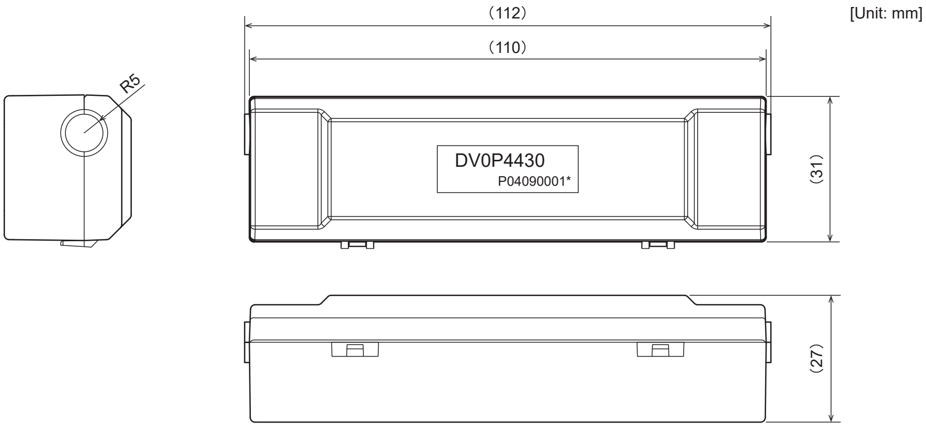
### ■ Connectors for connecting absolute encoder batteries

| Name | Product number | Manufacturer |
|---|---|---|
| Connector | ZMR-2 | J.S.T. Mfg. Co., Ltd. |
| Connector pin | SMM-003T-P0.5 | J.S.T. Mfg. Co., Ltd. |
| Recommended manual clamping jig | YRS-800 | J.S.T. Mfg. Co., Ltd. |

### ■ Battery box

| Product name | Optional product number |
|---|---|
| Battery box | DV0P4430 |

**Components**



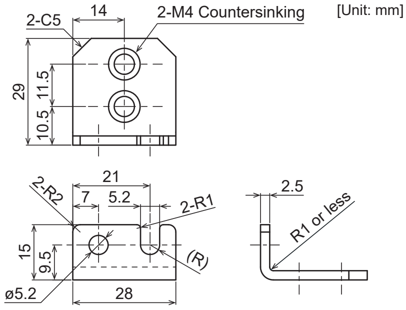
## 12.4.10 Mounting Bracket

| Product name | Optional product number | Applicable servo driver size symbol | Quantities of optional items |
|---|---|---|---|
| Mounting bracket | DV0PM24689 | Size A<br>Size B | ● Upper and lower brackets: 2 pcs.<br>● M4 × 6 flat head screws: 4 pcs. |
| | DV0PM24690 | Size C<br>Size D | ● Upper bracket: 1 pc.<br>● Lower bracket: 1 pc.<br>● M4 × 6 flat head screws: 4 pcs. |

### ■ Dimensions

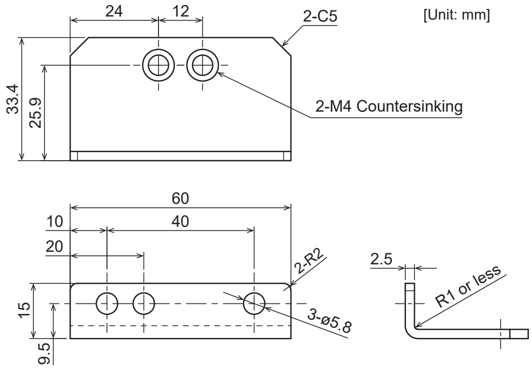
DV0PM24689

**Same for upper and lower**

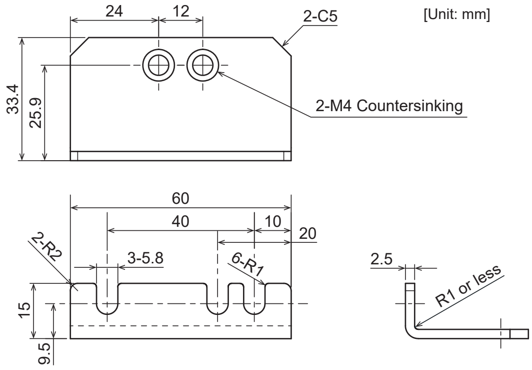


DV0PM24690

**Upper**



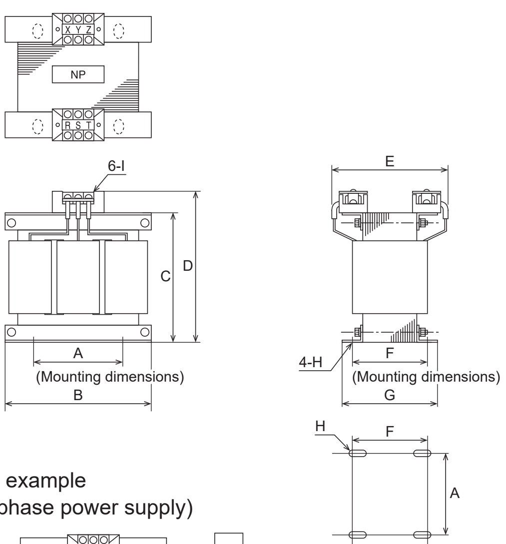
**Lower**



## 12.4.11 Reactor

| Product name | Figure | Optional product number | A (mm) | B (mm) | C (mm) | D (mm) | E (Max) (mm) | F (mm) | G (mm) | H (mm) | I (mm) | Inductance (mH) | Rated current (A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reactor | Figure 1 | DV0P220 | 65 ± 1 | 125 ± 1 | (93) | 136Max | 155 | 70+3/-0 | 85 ± 2 | 4-7φ×12 | M4 | 6.81 | 3 |
| | | DV0P222 | 60 ± 1 | 150 ± 1 | (113) | 155Max | 140 | 70+3/-0 | 85 ± 2 | 4-7φ×12 | M4 | 2 | 8 |
| | Figure 2 | DV0P227 | 55 ± 0.7 | 76.5 ± 1 | 66.5 ± 1 | 110Max | 90 | 43.6 ± 2 | 56 ± 2 | 4-5φ×10 | M3.5 | 4.02 | 5 |
| | | DV0P228 | 55 ± 0.7 | 76.5 ± 1 | 66.5 ± 1 | 110Max | 95 | 48.0 ± 2 | 61 ± 2 | 4-5φ×10 | M3.5 | 2 | 8 |

Figure 1



F: Distance between centers of outer arcs

Wiring example (for 3-phase power supply)

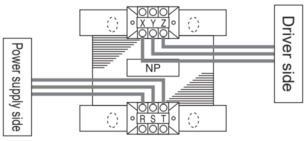
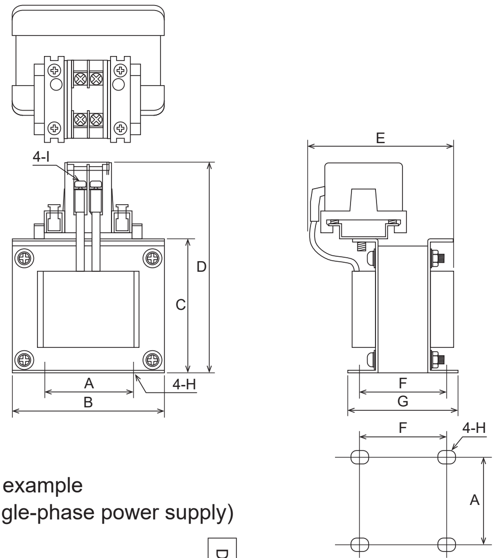
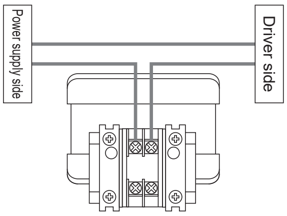


Figure 2



F: Distance between centers of long holes

Wiring example (for single-phase power supply)



| Driver part no. | Voltage specification | Motor rated output | Reactor product number |
|---|---|---|---|
| MADN061☐☐ | Single phase 100 V | 50 W | DV0P227 |
| MADN081☐☐ | | 100 W | |
| MBDN121☐☐ | | 200 W | DV0P228 |
| MCDN201☐☐ | | 400 W | |
| MADN065☐☐ | Single phase 200 V | 50 W | DV0P227 |
| MADN065☐☐ | | 100 W | |
| MADN085☐☐ | | 200 W | |
| MBDN125☐☐ | | 400 W | DV0P228 |
| MCDN205☐☐ | | 750 W | |
| MDDN405☐☐ | | 1000 W | |
| MADN065☐☐ | 3-phase 200 V | 50 W | DV0P220 |
| MADN065☐☐ | | 100 W | |

| Driver part no. | Voltage specification | Motor rated output | Reactor product number |
|---|---|---|---|
| MADN085□□ | 3-phase 200 V | 200 W | DV0P220 |
| MBDN125□□ | | 400 W | |
| MCDN205□□ | | 750 W | |
| MDDN405□□ | | 1000 W | DV0P222 |

Select a reactor that matches the driver product number and voltage specifications.

**Notes**

- For driver and motor combinations, refer *“2.3 Driver and Motor Combinations”* .

### ■ Harmonics suppression measures

Harmonics suppression measures vary by country. Install in accordance with local regulations.

In September 1994, the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry (formerly the Ministry of International Trade and Industry) established the “Guidelines for harmonics suppression measures on heavy consumers who receive power through high voltage systems or extra-high voltage systems” and “Guidelines for harmonics suppression measures on household electrical appliances and general-purpose articles” for products sold in Japan. According to these guidelines, the Japan Electrical Manufacturers’ Association (JEMA) has prepared technical references (procedures to implement harmonics suppression measures: JEM-TR 198, JEMTR 199 and JEM-TR 201) and has requested cooperation and understanding from users. Beginning in January 2004, general-purpose inverters and servo drivers were excluded from the “Guidelines for harmonics suppression measures on household electrical appliances and general-purpose articles”. Subsequently, the “Guidelines for harmonics suppression measures on household electrical appliances and general-purpose articles” were abolished on September 6, 2004.

The procedure to implement harmonics suppression measures on general-purpose inverters and servo drivers has now been modified as follows.

1. Regarding general-purpose inverters and servo drivers for heavy consumers, products whose input current exceeds 20 A are subject to the “Guidelines for harmonics suppression measures for users who receive power through high-voltage or extra-high voltage systems”. All consumers required to apply these guidelines must calculate the equivalent capacity and harmonic outflow current based on the guidelines. If the harmonic current is found to exceed the limit value predetermined for the contract demand, appropriate measures must be taken.

   Furthermore, when calculating the equivalent capacity, assume that the conversion factor of the servo driver is K31 = 3.4 (See JEM-TR 210 and JEM-TR 225.*).

2. The “Guidelines for harmonics suppression measures on household electrical appliances and general-purpose articles” was abolished on September 6, 2004. However, based on conventional guidelines, JEMA applies the technical references JEM-TR226 and JEM-TR227 to any users who do not fit into the “Guidelines for harmonics suppression measures on heavy consumers who receive power through high voltage system or extra high voltage system” from a perspective on enlightenment on general harmonics suppression measures. The purpose of these guidelines is to ensure implementation of harmonics suppression measures by users on all devices possible, as before the changes.

   * Technical reference issued by the Japan Electrical Manufacturers’ Association (JEMA).

### 12.4.12 External Regenerative Resistor

The following resistors are recommended for use as external regenerative resistors.

| Product name | Optional product number | Manufacturer (*3) format | Specifications | | | | | Internal thermal protector operating temperature |
|---|---|---|---|---|---|---|---|---|
| | | | Resistance value | Core cable outer diameter | Mass | Rated power (reference value) (*1) | | |
| | | | | | | Free air | Fan used (*2) | |
| | | | Ω | mm | kg | W | W | |
| External regenerative resistor | DV0P4280 | RF70M | 50 | φ1.27<br>(AWG18)<br>Stranded wire | 0.1 | 10 | 25 | 140 ± 5 °C<br>B contact<br>Switching capacity (resistance load) 1 A 125 V AC 6000 times<br>0.5 A 250 V AC 10000 times |
| | DV0P4281 | RF70M | 100 | | 0.1 | 10 | 25 | |
| | DV0P4282 | RF180B | 25 | | 0.4 | 17 | 50 | |
| | DV0P4283 | RF180B | 50 | | 0.2 | 17 | 50 | |
| | DV0P4284 | RF240 | 30 | | 0.5 | 40 | 100 | |

*1 Power available without running the built-in thermal protector

Each regenerative resistor has a built-in thermal fuse and thermal protector for safety.

When using a thermal protector, configure the circuit to turn off the power supply (Refer to *“3.2.1 Wiring to the Main Circuit”* ).

The built-in thermal fuse may break due to heat dissipation conditions, operating temperature range, power supply voltage, or load fluctuation.

When operating in conditions where the regenerative resistor is likely to generate heat (e.g., when the power supply voltage is high, when load inertia is large, or when deceleration times are short), incorporate it into the device to ensure that the surface temperature of the regenerative resistor remains at less than 100°C and confirm the operation thereof.

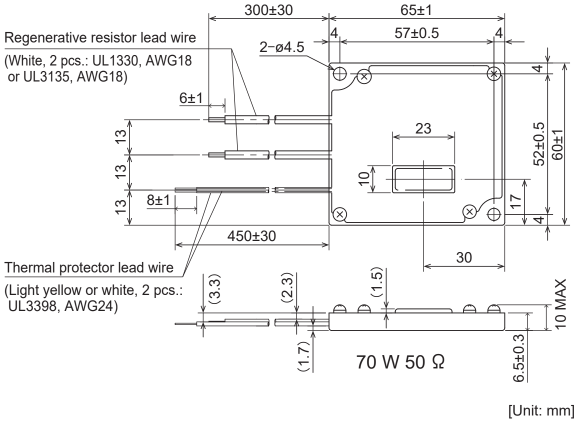
*2 If the fan is used for wind speeds of at least 1 m/s

*3 Manufacturer: Iwaki Musen Kenkyusho

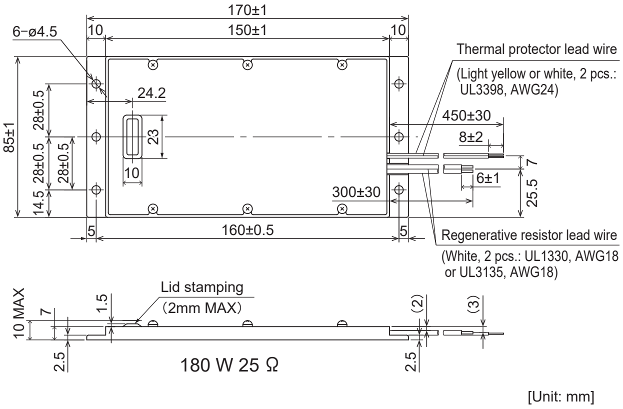
Driver and external regenerative resistor combinations are shown below.

| Driver part no. | Driver voltage specifications | Regenerative resistor |
|---|---|---|
| | | Optional product number |
| MADN061☐☐ | Single phase 100 V | DV0P4280 |
| MADN081☐☐ | | |
| MBDN121☐☐ | | DV0P4283 |
| MCDN201☐☐ | | DV0P4282 |
| MADN065☐☐ | Single phase/3-phase 200 V | DV0P4281 |
| MADN085☐☐ | | DV0P4283 |
| MBDN125☐☐ | | |
| MCDN205☐☐ | | |
| MDDN405☐☐ | | DV0P4284 |

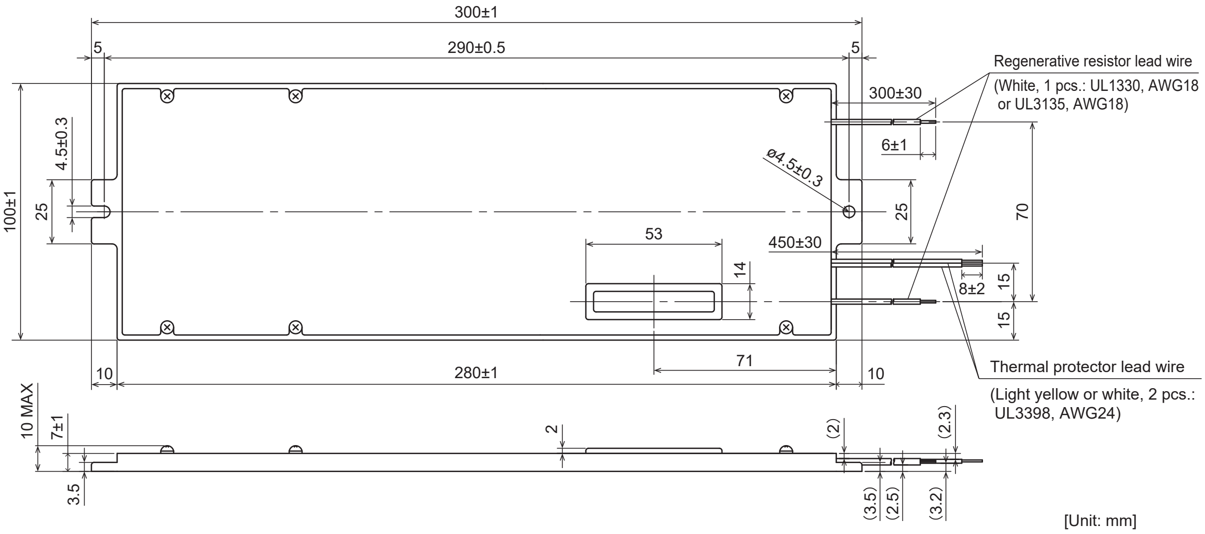
### DV0P4280, DV0P4281



### DV0P4282, DV0P4283



### DV0P4284



**— Precautions —**

- Regenerative resistors can become hot.
  - Structure circuits such that the thermal protector in the regenerative resistor works by cutting off the power supply.
  - The thermal protectors recover automatically. Create an external self-holding circuit to prevent unsafe conditions if the thermal protector activates suddenly.
  - When drivers malfunction, the outer surface of the regenerative resistor may reach temperatures higher than operating temperatures before the thermal protector activates.
  - The thermal fuses in regenerative resistors are intended to prevent combustion of regenerative resistors when drivers malfunction, and not for control of resistor surface temperatures.
- Install the regenerative resistor to nonflammable materials such as metal.
- Install the regenerative resistor so that it cannot be touched directly, such as by covering it with non-combustible material.
- Sections that can be touched directly should be kept to less than 70°C.
- Do not install regenerative resistors near flammable materials.

### 12.4.13 Surge Absorber for Motor Brake

Recommended parts

| Motor | | Manufacturer product number | Manufacturer |
|---|---|---|---|
| MHMG | 50 W to 1000 W (□80) | TND14V-271K | Nippon Chemi-con |

### 12.4.14 List of Peripheral Device Manufacturers

| Manufacturer | Phone number | | Peripheral device name |
|---|---|---|---|
| Iwaki Musen Kenkyusho | 044-833-4311 | | Regenerative resistor |
| Nippon Chemi-con | Kanto Region | 03-5436-7711 | Surge absorber for holding brake |
| | Chubu Region | 052-772-8551 | |
| | Kansai Region | 06-6338-2331 | |
| SEMITEC Corporation | Kanto Region | 03-3621-2703 | |
| | Kansai Region | 06-6391-6491 | |
| KOA CORPORATION Musashino Plant | 042-336-5300 | | |
| TDK Corporation | Kanto Region | 03-5201-7229 | Ferrite core |
| | Chubu Region | 052-971-1712 | |
| | Kansai Region | 06-6632-8140 | |
| Nisshin Electric Co., LTD. (MICROMETALS) | 04-2934-4151 | | |
| Konno Kogyosho Co., Ltd. | 0184-53-2307 | | |
| Okaya Electric Industries | East Japan | 03-4544-7040 | Surge absorber<br>Noise filter |
| | West Japan | 06-6341-8815 | |
| Japan Aviation Electronics Industry, Ltd. | Kanto Region | 03-3780-2717 | Connector |
| | Chubu Region | 0565-34-0600 | |
| | Kansai Region | 06-6447-5255 | |
| 3M Japan | Kanto Region | 03-5716-7290 | |
| | Chubu Region | 052-220-7083 | |
| | Kansai Region | 06-6447-3944 | |
| Tyco Electronics Japan G.K.CIS Business Unit | 044-844-8052 | | |
| Molex Japan LLC | Kanto Region | 0462-65-2313 | |
| | Chubu Region | 052-232-3977 | |
| | Kansai Region | 06-6377-6760 | |
| J.S.T. Mfg. Co., Ltd. | Kanto Region | 045-543-1271 | |
| | Chubu Region | 0561-33-0600 | |
| | Kansai Region | 06-6210-2130 | |
| Dyden Corporation | Kanto Region | 03-5805-5880 | Cable |
| | Chubu Region | 052-968-1710 | |
| | Kansai Region | 06-6229-1881 | |
| Magnescale Co., Ltd. | 03-6632-7923 | | External scale |
| Nidec Instruments Corporation | 03-5740-3000 | | |
| Renishaw plc | Tokyo HQ | 03-5366-5317 | |
| | Nagoya Branch | 052-961-9511 | |
| Fagor Automation S.Coop | +34-943-719-200<br>*“http://www.fagorautomation.com”* | | |
| Nidec Machine Tool Corporation | 075-861-3313 | | |
| RSF Elektronik GmbH | 03-3234-7781 | | |
| Soshin Electric Co., Ltd. | Kanto Region | 03-5730-8001 | Noise filter |
| | Chubu Region | 052-930-5051 | |
| | Kansai Region | 06-6396-7701 | |
| Schaffner EMC | 03-5712-3650 | | |
| TDK-Lambda Corporation | 03-5201-7140 | | |

The above contact information is current as of January 2024.

The List of Peripheral Device Manufacturers is intended only as a reference, and is subject to change without prior notice.

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# 13 Warranty

## Warranty Period

The warranty period for products is 1 year from purchase, or 1 year and 6 months from the month of production by Panasonic.

However, for motors with brakes, the number of accelerations and decelerations of the axis must not exceed the product's life span. This does not apply to motor replacement parts (oil seal) (Only with oil seal).

The following cases are excluded even during the warranty period.

- When caused by incorrect usage or inappropriate repairs or modifications
- When caused by falling post-purchase or damage during shipping
- When caused by usage outside the scope of product specifications
- When caused by fire, earthquake, lightning, wind or water damage, salt damage, voltage anomalies, or other natural disaster or force majeure
- When caused by infiltration of water, oil, metal flakes or other foreign matter
- When individual parts with listed standard lifetimes which have exceeded said lifetimes

## Warranty Coverage

Only malfunctioning component replacements or repairs are covered for individual devices delivered by Panasonic, in the event of malfunctions attributable to Panasonic during the warranty period. Please note that our above-stated responsibility is limited to the replacement and repair of the equipment provided by us and that we do not accept any responsibility for damage to your company or any third party that may occur in connection with the failure of the equipment provided by us.

Panasonic is not liable in any way for device malfunctions or damages incurred by your company or third parties in the event of any exemptions listed under *“Warranty Period”* or in any of the following cases.

- When the device is assembled or used counter to the precautions and directions listed in this document
- When caused by the combination of the device and devices it is incorporated into
- When we are unable to process your request regarding this document
- When the device malfunction is otherwise not attributable to our company

## Warranty Service

If you require warranty service (fault cause investigation, repair, etc.), please contact the retailer from which you purchased the product.

If you wish to send it directly to us with the permission of the retailer, please receive a repair/investigation request form from the place of purchase, fill out the necessary information, and send it to our motor service desk along with the product.

As a general rule, you will be responsible for shipping costs.

# 14 Glossary

Abbreviations used in this document and their official names are shown below.

## ■ Servo Driver-related/Servo Motor-related

| Abbreviation | Official Name |
|---|---|
| CCW | Counterclockwise Rotation |
| csp | Cyclic synchronous position mode |
| cst | Cyclic synchronous torque mode |
| cstca | Cyclic synchronous torque mode with commutation angle |
| csv | Cyclic synchronous velocity mode |
| CW | Clockwise Rotation |
| DB | Dynamic Brake |
| EDM | External Device Monitoring |
| FB | Feedback |
| FF | Feed forward |
| FFT | Fast Fourier Transform |
| FIR | Finite Impulse Response |
| hm | Homing mode |
| HPF | High Pass Filter |
| ip | Interpolated position mode |
| LSD | Least Significant Digit |
| LV | Low Voltage |
| MSD | Most Significant Digit |
| OSS | Open Source Software |
| pp | Profile position mode |
| pv | Profile velocity mode |
| Recv | Receive |
| RTAT | Real-Time Auto Tuning |
| SRV | Servo |
| SSU | STO Signal Unmatch |
| STO | Safe Torque Off |
| TFF | Torque Feed Forward |
| tq | Torque profile mode |
| vl | Velocity mode |

## ■ EtherCAT Communication-related

| Abbreviation | Official Name |
|---|---|
| AL | Application Layer |
| Boot | Bootstrap |
| CoE | CANopen over EtherCAT |
| DC | Distributed Clocks |
| ENI | EtherCAT Network Information |
| EoE | Ethernet over EtherCAT |

| Abbreviation | Official Name |
|---|---|
| ESC | EtherCAT SubDevice Controller |
| ESI | EtherCAT SubDevice Information |
| ESM | EtherCAT State Machine |
| ETG | EtherCAT Technology Group |
| FMMU | Fieldbus Memory Management Unit |
| FoE | File Access over EtherCAT |
| FSA | Finite State Automaton |
| OP | Operational |
| PDI | Physical Device Interface |
| PDO | Process Data Object |
| PDS | Power Drive Systems |
| PreOP | Pre-Operational |
| RxPDO | Receive PDO |
| SafeOP | Safe-Operational |
| SDO | Service Data Object |
| SII | SubDevice Information Interface |
| SM | SyncManager |
| SoE | Sercos over EtherCAT |
| TxPDO | Transmit PDO |
| VoE | Vendor-specific over EtherCAT |

## ■ Object-related

### Data type

| Abbreviation | Official Name |
|---|---|
| U8 | Unsigned8 |
| U16 | Unsigned16 |
| U32 | Unsigned32 |
| I8 | Integer8 |
| I16 | Integer16 |
| I32 | Integer32 |
| VS | Visible String |
| BOOL | Boolean |
| OS | Octet String |

### Access

| Abbreviation | Official Name |
|---|---|
| r | read |
| rw | read-write |
| ro, RO | read-only |
| c | constant |

# REVISIONS

| Date | Rev. | Page | Description |
|---|---|---|---|
| Jan. 7, 2025 | 0.0 | — | NEWLY ISSUED |
| Apr. 1, 2025 | 0.1 | 1.5.4 | Changed Function (Add to Unsupported Features)<br>● position comparison output function<br>● Monitor Signal Output |
| Apr. 11, 2025 | 1.0 | 1.5.2, 1.5.6 | Software version upgrade<br>● CPU1: Ver1.04→Ver1.05<br>● Manufacture Software: Ver1.00→Ver1.01 |
| | | 1.5.4 | Remove from the list of Unsupported Features<br>● position comparison output function<br>● Monitor Signal Output |
| | | 3.2.8.1 | Added description of operating conditions for Monitor Signal Output |
| | | 4.1.3 | Added restrictions for each control mode<br>● Cycle time (DC, SM2 communication cycle) |
| | | 4.2.2 | Changed the default value<br>● ESC Register Byte Address: 0002h to 0003h |
| | | 5.3.3 | Corrected typographical errors<br>● Protection Functions Description |
| | | 6.2.2.8 | Updated Object Dictionary List<br>● Changed the Initial value of 3780h<br>● Add 37B7h |
| | | 6.2.2.11 | Updated Object Dictionary List<br>● Add 3A01h |
| | | 8.3 | Added description of operating conditions for Position comparison output function |
| | | 10.2.3 | Changed Protection Function Details<br>● Err80.3.0 (Primary cause/Detected ESM state/ESM state after detection/Handling/Related objects)<br>● Err81.1.0 (Primary cause) |
| May 28, 2025 | 1.1 | 4.2.4, 6.6.8.4.4, 7.3.2, 7.3.3, 7.4.2, 7.4.3, 7.6.2, 7.6.3, 8.7.1, 10.2.5 | Added Description |

| Date | Rev. | Page | Description |
|---|---|---|---|
| | | 6.6.8.7, 10.3.2, 11.2, 11.8 | Corrected typographical errors |

# Repairs, Inquiries and Technical Information

## Repairs

Contact your dealer regarding repairs.

If installed in a machine or device, consult with the machine or device manufacturer first.

## Contact us

If you have any questions, please contact the seller of the product (Sales office or Distributor).

## Technical information

- **Operating instructions, technical reference, CAD data downloads, and Web-based inquiries are available online.**

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